

# Radiocarbon dating archaeobotanical remains from Stafford

Mark McKerracher

The aim of this report is to produce a firm chronology for the Anglo-Saxon and medieval charred plant remains from Stafford, drawing upon radiocarbon dates obtained by the Feeding Anglo-Saxon England project (FeedSax) in 2018, as well as those from earlier studies. These archaeobotanical remains come from three separate excavations within the bounds of the medieval town, at (1) St Mary's Grove, led by Jon Cane, 1979–84; (2) Bath Street, led by Roy Barnes, 1981; and (3) Tipping Street, excavated and monitored by Oxford Archaeology in 2009–10. Specifically, the latter excavations were on the site of the Tipping Street/South Walls car park, close to but distinct from earlier Tipping Street excavations in the 1970s and 1980s which did not produce enough charred plant remains to warrant inclusion in the FeedSax archaeobotanical studies. The St Mary's Grove and Bath Street excavations discussed here are among those published by Carver (2010); they were part of the 'Carver/Cane' excavation campaign of 1975–85.

Since the three excavations considered here have produced quite different contexts and occupation sequences, it makes most sense to assess the chronology of each site independently, before attempting to construct a comprehensive sequence for Stafford as a whole.

Note that all charred cereal grains radiocarbon-dated by the FeedSax project were photographed by the author prior to submission for dating; these photographs are included in the project's photographic archive (McKerracher *et al.* in prep.).

## St Mary's Grove

### *The settlement sequence*

The largest of the open-area excavations of the Carver/Cane campaigns were conducted at St Mary's Grove. Amongst the excavated features, Carver has discerned seven periods of occupation, from the Iron Age to the sixteenth century and later.

- Period 1 (Iron Age: late first millennium BC)
- Period 2 (Roman: first to fourth centuries AD)
- Period 3 (tenth to eleventh centuries)
- Period 4 (Norman, eleventh to twelfth centuries)
- Period 5 (late twelfth to thirteenth centuries)
- Period 6 (thirteenth to sixteenth centuries)
- Period 7 (post-medieval: sixteenth century and later)

Carver has also identified three distinct areas of the site: a north-east area, a central area, and a south-west area. Since each area seems to show a distinct developmental sequence, each will now be discussed separately in turn.

### *North-east*

In the north-east area was a group of features assigned a Late Saxon date by Carver (Period 3): a group of ovens or kilns interpreted as grain dryers and baking ovens, a pebbled hard-standing F134,

well F608, and pit F136 (Carver 2010, 29). Dendrochronology shows that the well was relined in AD 1007, ‘and thus had probably been already working in the tenth century’ (Carver 2010, 31). According to Carver’s chronology, activity in this area ended – ‘the ovens were extinguished’ – around the time of the Norman Conquest, and layer 1607 accumulated over the top of this area (Carver 2010, 103). The layer contained only five sherds of (Late Saxon) St Neots Ware pottery. Subsequently, pits and postholes were cut into this layer. Pit F449 cut oven F585 (S14), and among its potsherds only Stafford Ware was represented (Carver 2010, 108). Pit F443, meanwhile, cut the pebbled hard-standing and contained only medieval coarse-ware cooking pot (Carver 2010, 108). The timber lining of another one of these pits, F404, was felled later than 1173 and probably later than 1183.

Well F608, however, may have remained in use throughout these turbulent periods: ‘refurbished in AD 1007, [it] stayed open and was perhaps still functioning until the first sherds of coarse-ware cooking pot were dropped in it’ (Carver 2010, 103). The relationship of well F608 to other features in the north-east part of the site appears to be stratigraphically complicated: ‘F608 is recorded as cutting layer 1607, but an important aspect of this layer, recorded by the excavator, is that it was homogeneous and that it was continually being developed during the life of the ovens. Thus it is not improbable that F608 was contemporary with its neighbouring ovens. Its final fill contained a single EVE (equivalent of one vessel) of type 17A cooking pot, suggesting that it lay open until after the conquest’ (Carver 2010, 69).

While Period 6 activity was concentrated in the south-west area (discussed below), post-medieval Period 7 activity was focused back in the north-east, where ‘the construction of a rectangular building (S3) and a malting kiln (S15) suggest a brewery’ (Carver 2010, 35). These developments succeeded ‘an extensive levelling layer (1341/1710) which contained post-medieval pottery’ (Carver 2010, 122).

Samples with charred plant remains from the north-east area come from the following features:

- Period 3: Late Saxon oven features **130** (S4), **214** (S5, two contexts), **581** (S5, specifically the flue), **584** (S12), and **585** (S14, three contexts); Late Saxon pit **136** (three contexts).
- Period 3–4: well **F608** (two contexts – mostly waterlogged but some charred material).
- Period 5: two contexts from each of pits **F443** and **449**.
- Period 7: one context from pit **176**, and two contexts from oven **188**.

### ***Central***

The central area was dominated by very large quarrying pits (F426, F435, F480) dated by Carver to the twelfth century (Period 4). He argues that these quarry pits are likely to have obliterated earlier activity in this area, and that the masses of charred grain in the backfill represent redeposited material from Late Saxon grain-processing activity (Carver 2010, 31): ‘Quantities of Stafford ware and charred grain were redeposited in the central quarries (F435, F426), showing that a major area of Late Saxon grain processing had been effaced’, following a conflagration.

‘We have no date for the fire,’ writes Carver (2010, 103), ‘but the clearing up operation took place at a time when medieval coarse ware was plentiful, and the latest quarry pit (F290) also received a few sherds of white-ware jug. If this backfilling and restart was a single episode, it should belong to the later twelfth or early thirteenth century.’

Also in the central area is a sunken-featured building (S16) dated to the Late Saxon phase (Period 3), immediately to the south of the quarry pits. Its timbers appear to have been burnt *in situ* – hence the inferred conflagration that is understood to have ended Late Saxon activity in this area. According to

Carver's description, this building 'floats stratigraphically between the subsoil and the quarry pits F426 etc. of Period 4' (Carver 2010, 69). Carver proposes that this building 'probably also served the grain processing industry as a store', but burnt down around the time of the Norman Conquest (p.103).

Samples with charred plant remains from the central area come from the following features:

- Period 3: four contexts from Late Saxon sunken-featured building **F517** (S16).
- Period 4: one context from quarry pit **F426** and two contexts (from one of which come four different grid square samples) from quarry pit **F435**.

### *South-west*

No features in the south-west area were dated to the Late Saxon phase (Period 3), but a large quarry pit (F290) was dated to the twelfth century (Period 4). A lengthy sequence of medieval (Period 5–6) activity followed, represented by post-hole buildings, pits, and a ditch (F298) at the area's southern edge. Pits were in use from Period 5 (late twelfth to thirteenth centuries), as dated by pottery and (in F342, one of the earliest such pits) a coin from the reign of King John, AD 1203–1218 (Carver 2010, 108). Carver describes the Period 6 (thirteenth- to sixteenth-century) developments in the south-west as being dominated by 'a stone-built grain-drying kiln (S8) and a substantial stone-founded building (S7), with a privy (F320)', while 'the pottery seriation suggests that medieval residence here continued without a break up to the fifteenth or sixteenth century' (Carver 2010, 122).

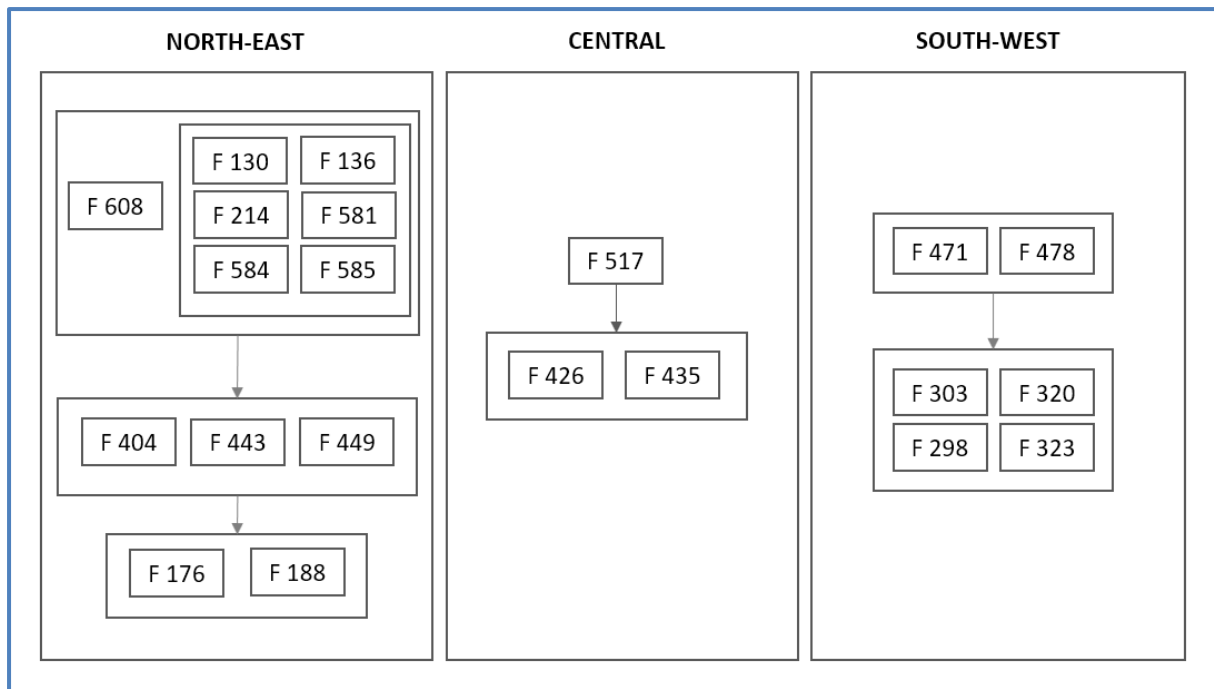
Samples with charred plant remains from the south-west area come from the following features:

- Period 5: one context from each of pits **F471** and **F478**.
- Period 6: two contexts from each of pits **F303**, **F320**, and ditch **F298**; and one context from kiln **F323**.

### *Summary*

The settlement sequences described above allow us to construct a framework for the dating of the features from this site which have produced archaeobotanical remains. This framework has been designed as a basis for Bayesian modelling of dates. The stratigraphic ordering is therefore the opposite of that in a Harris matrix: the earliest context is at the top of the diagram and the latest context is at the bottom. Stratigraphic relationships are illustrated by arrows, which point from earlier to later. The three different parts of the site are each treated as a separate sequence, since there do not appear to be any clear, direct stratigraphic relationships between the three zones, as far as could be ascertained from the published information.

Note that in the central area, although quarry pits F426 and F435 are said to post-date (stratigraphically) SFB F517, Carver believed the charred grain in the backfill of the quarry pits to be contemporary with that preserved in the SFB, both belonging, in his model, to the Late Saxon period.



### *Earlier scientific dating evidence*

The original post-excavation project obtained four radiocarbon dates from two contexts, one Iron Age and one Late Saxon. The Late Saxon context was 2247, in the ‘bread oven’ F584, and the dated material included a mixture of burnt wood and grain.

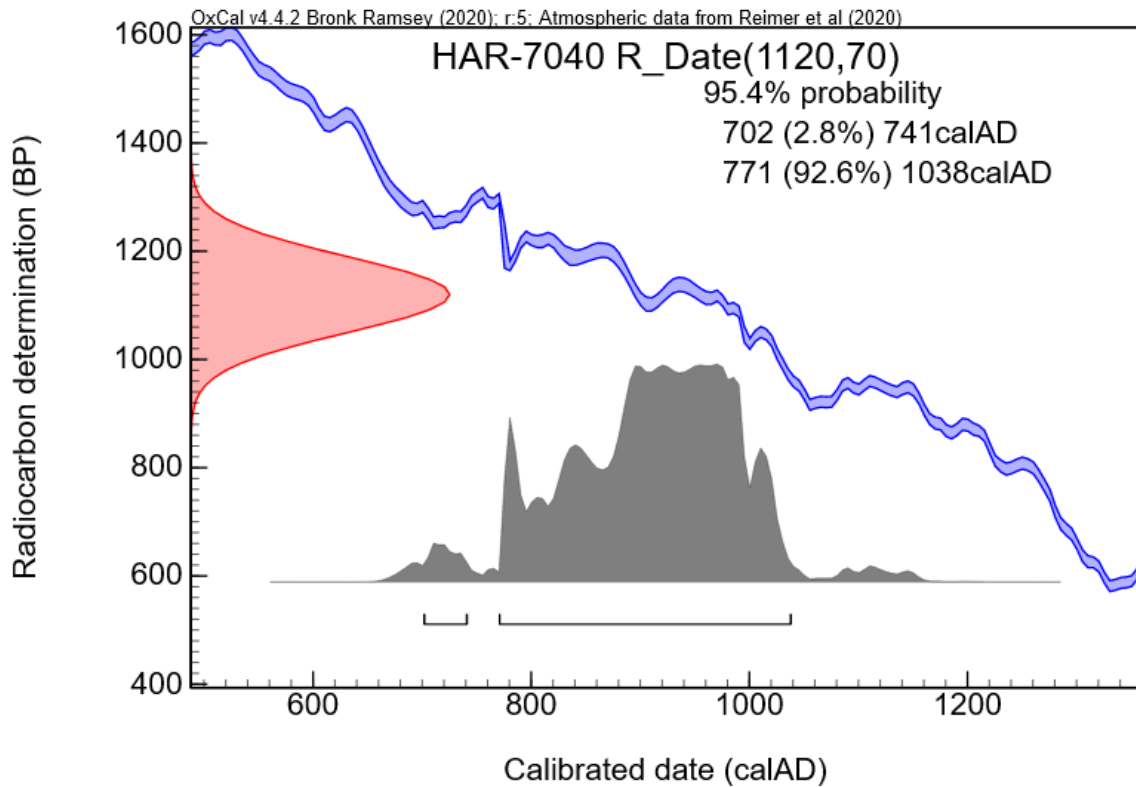
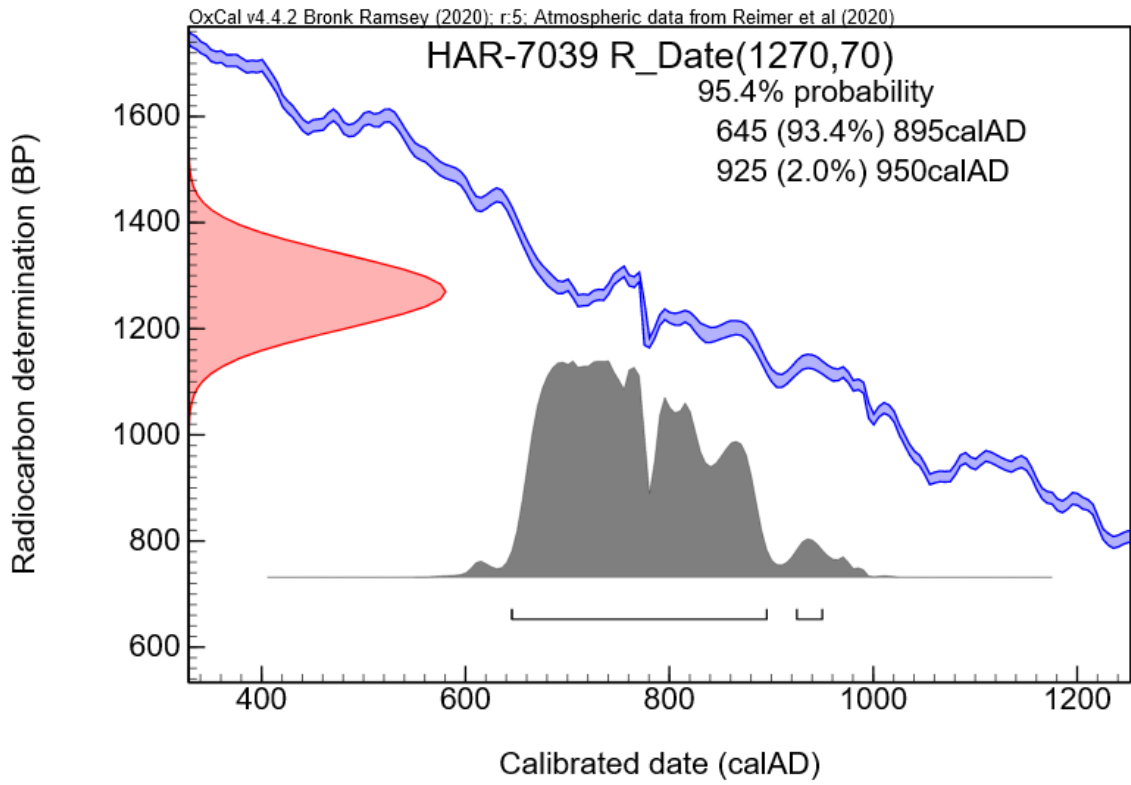
feature	context	material	laboratory no.	age BP	calibrated years AD (confidence)
F584 (S12)	2247	burnt wood and grain	HAR-7039	1270 ± 70	645–895 (93.4%)
F584 (S12)	2247	burnt wood and grain	HAR-7040	1120 ± 70	771–1038 (92.6%)
F584 (S12)	2247	burnt wood and grain	HAR-7041	1310 ± 90	577–896 (93.5%)

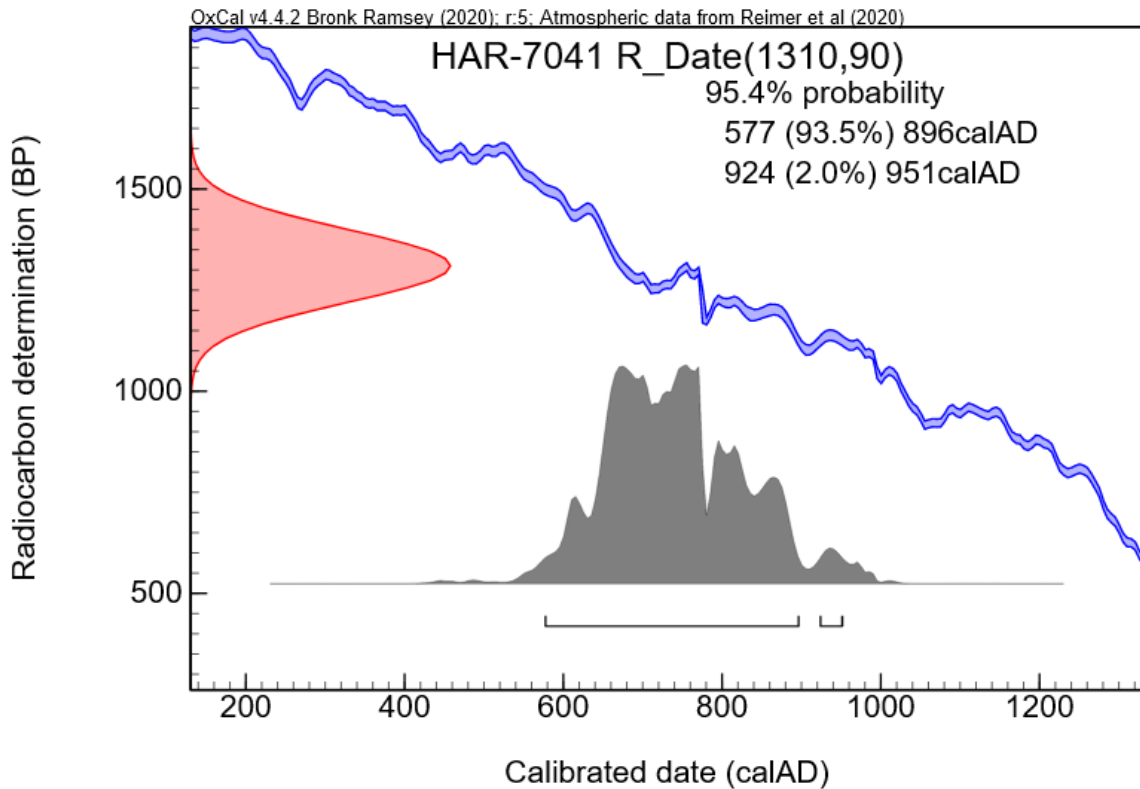
Citing earlier (i.e. pre-IntCal20) calibrated date ranges, Carver wrote that ‘one of these dates differs markedly from the other two, and although it might be tempting to conflate all three into the tighter bracket AD 720–890, the context does not really allow this, since it is essentially a mixture of wood used to fire an oven, potentially including heartwood. The most legitimate of the three then becomes the latest, 720–1020, although this date range is not particularly helpful. In any event, taking the three together does not justify the dating of this oven (and by extension the others) to the ninth century (and thus before the foundation of the burh) as proposed by J. Cane, quoted by Moffett and cited elsewhere’ (Carver 2010, 31).

These original Harwell dates are recalibrated below, and in the table above, using IntCal20 (Reimer *et al.* 2020) and OxCal 4.4.2 (Bronk Ramsey 2009).

In addition to these radiocarbon dates, timbers from two contexts were subjected to tree-ring dating (Carver 2010, 149). Thus wood the lining of well F608 was felled in AD 1007, and that lining pit F404 was felled later than AD 1173, and probably later than AD 1183:

feature	context	material	dendrochronological date
F608	2270	well-lining timbers	late spring/early summer AD 1007
F404	2145	cess pit-lining timbers	not before 1173, probably after AD 1183

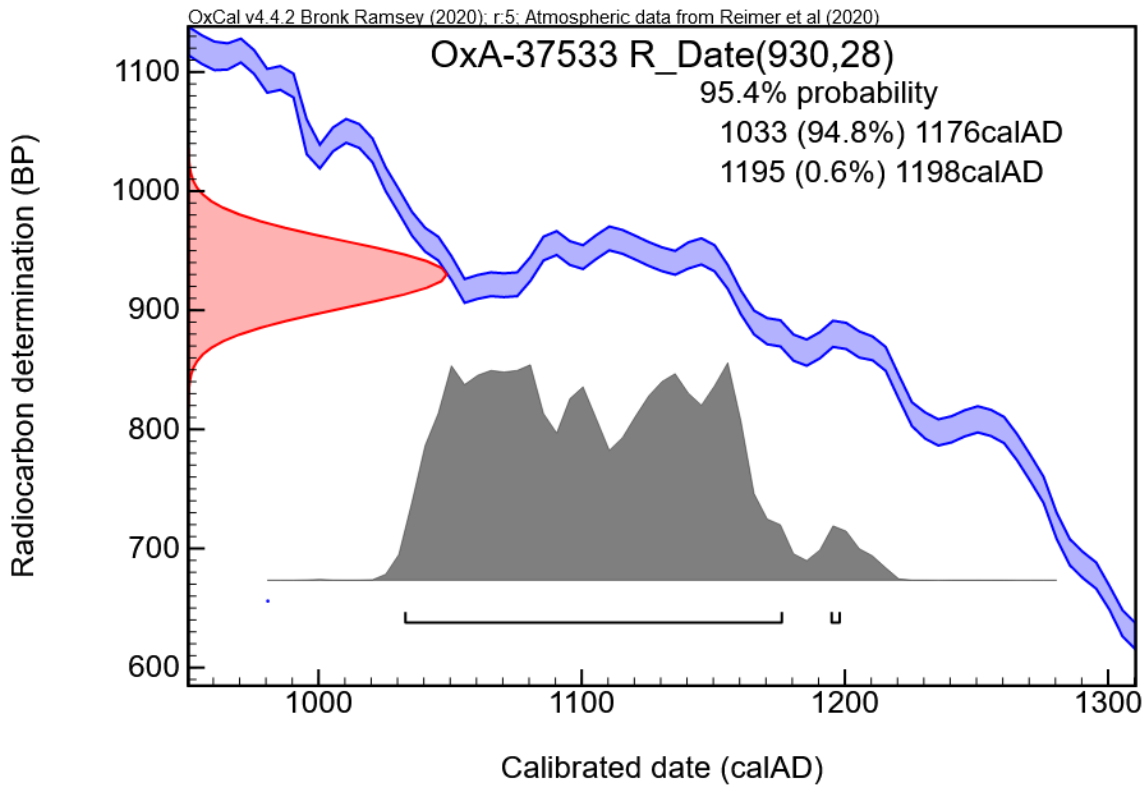
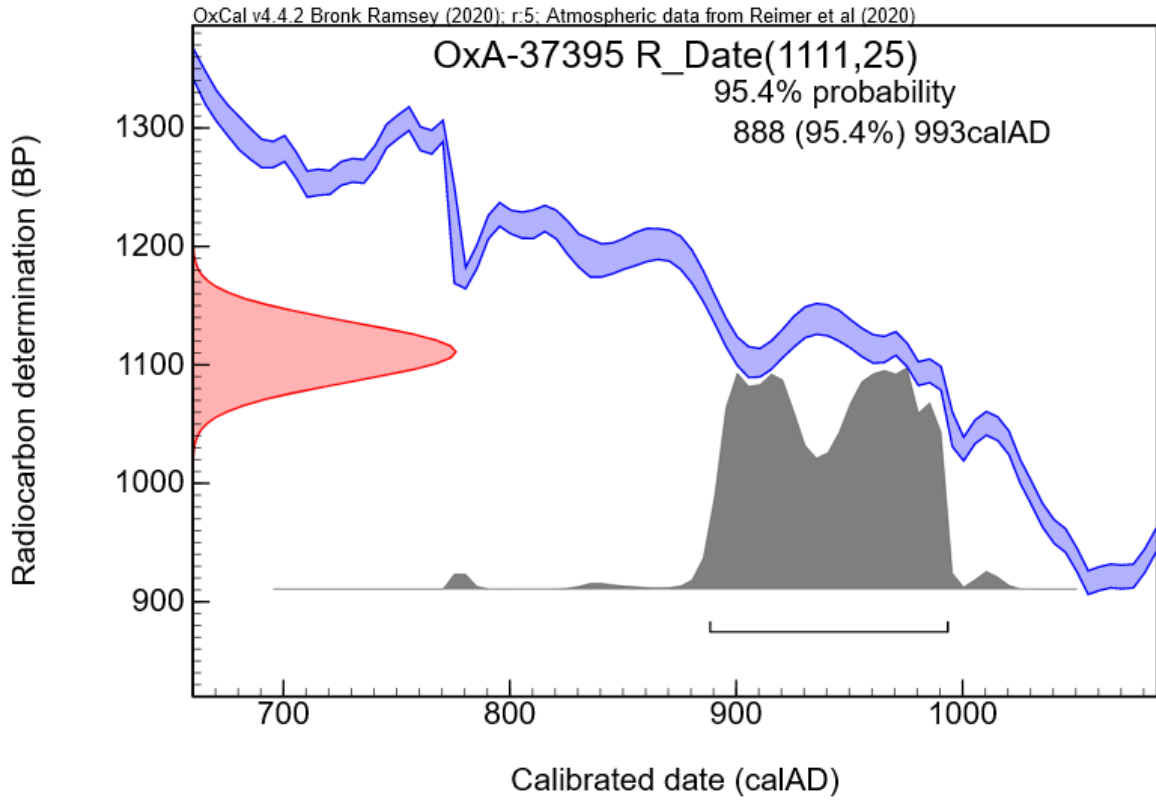


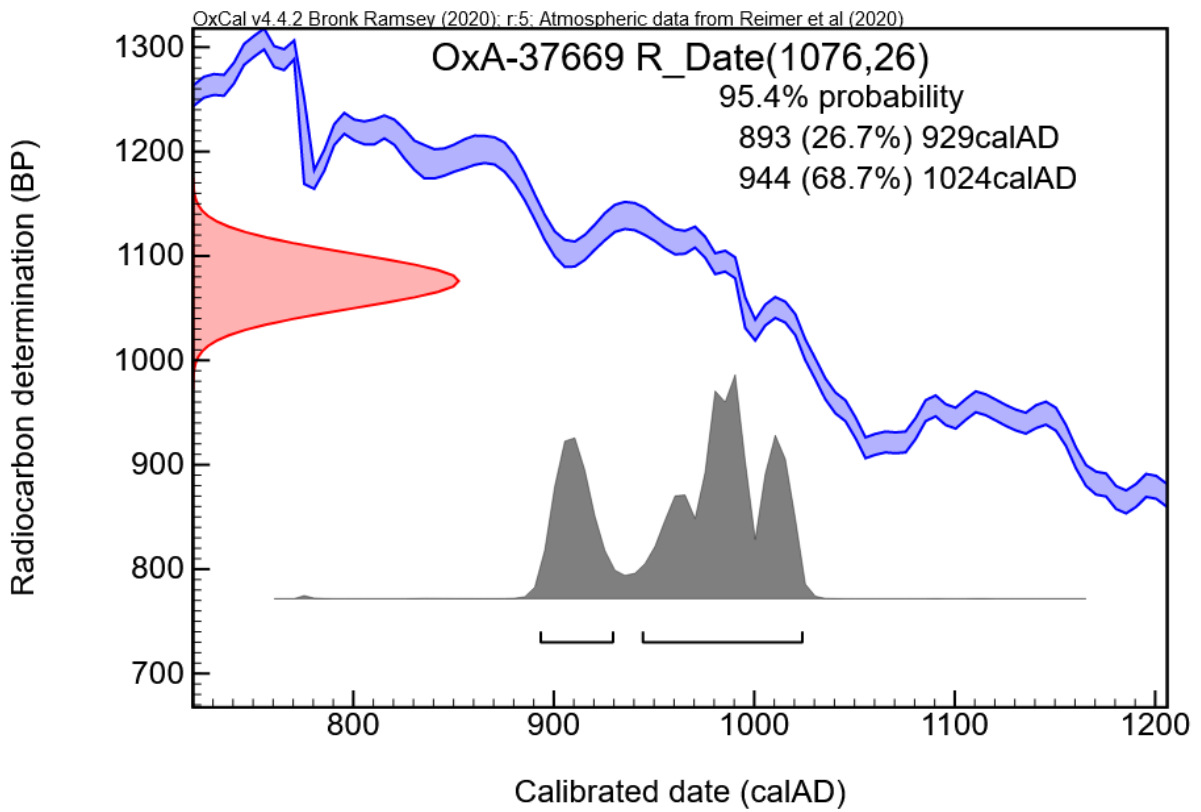
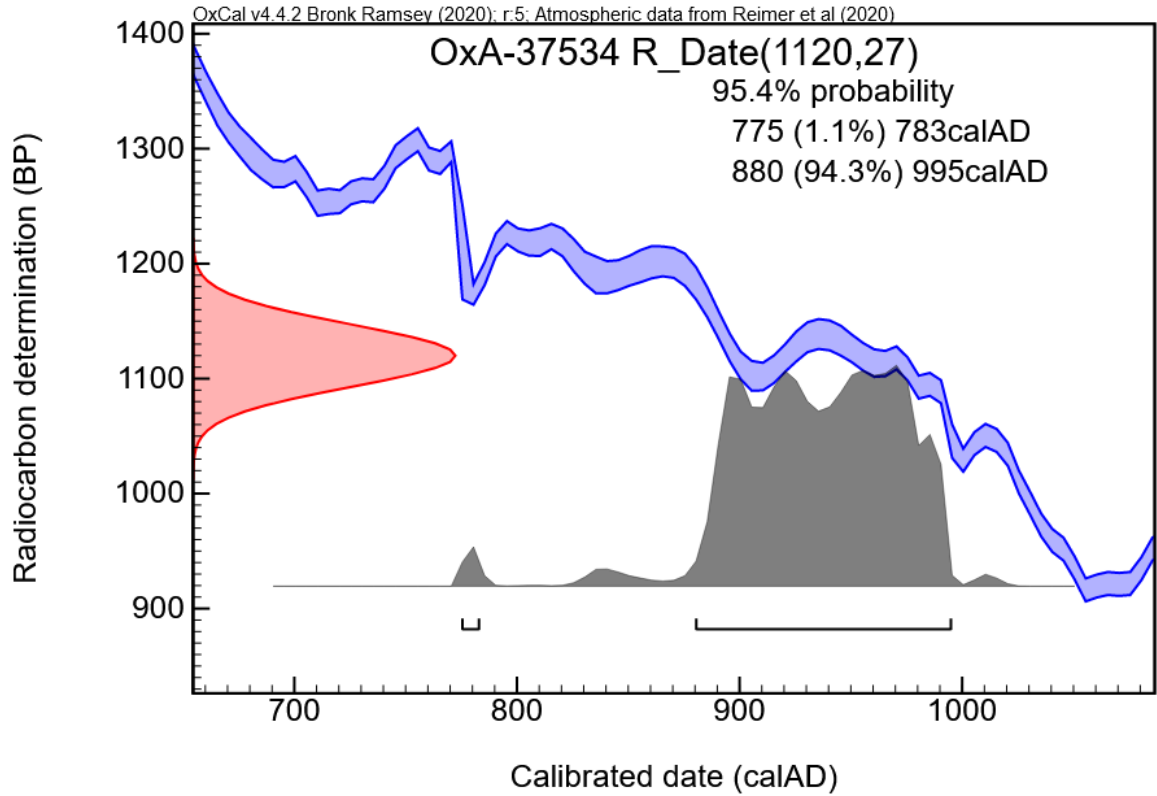


### *New radiocarbon dates*

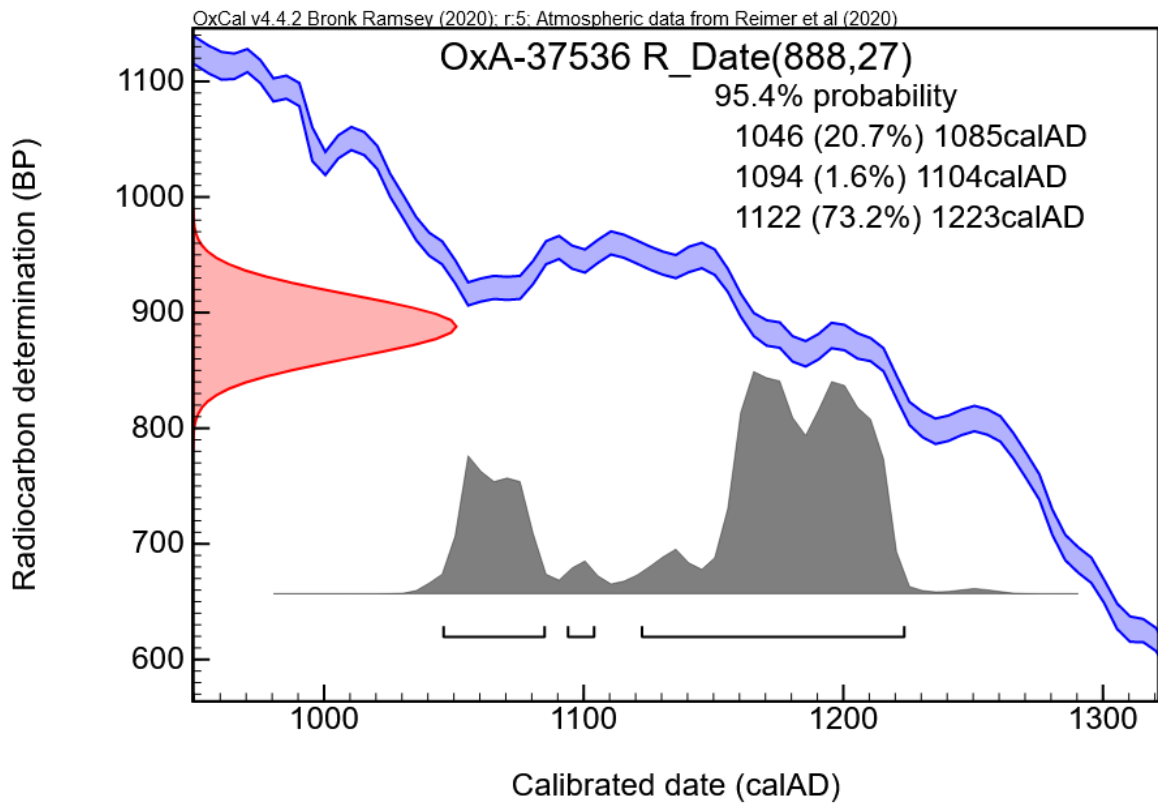
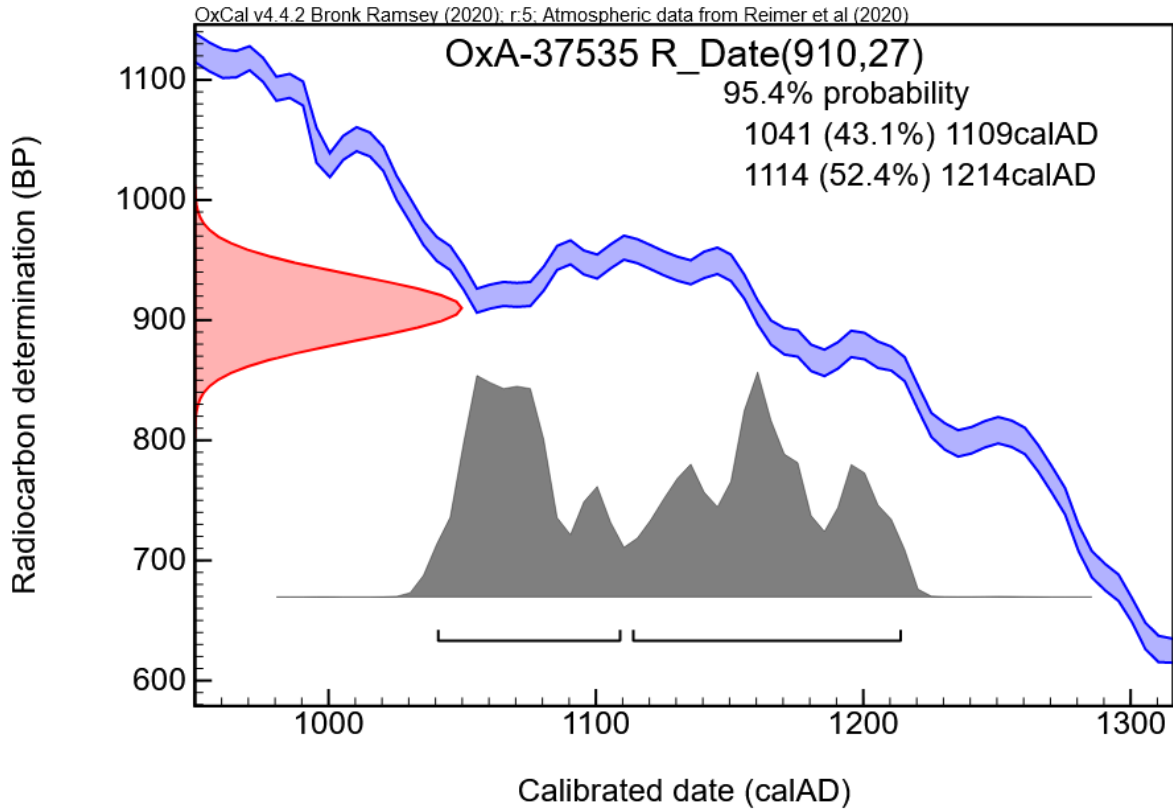
As part of the FeedSax project, charred grain samples from ten contexts were submitted to the Oxford Radiocarbon Accelerator Unit for radiocarbon dating. The results have been calibrated using IntCal20 (Reimer *et al.* 2020) and OxCal 4.4.2 (Bronk Ramsey 2009) in the table and figures below.

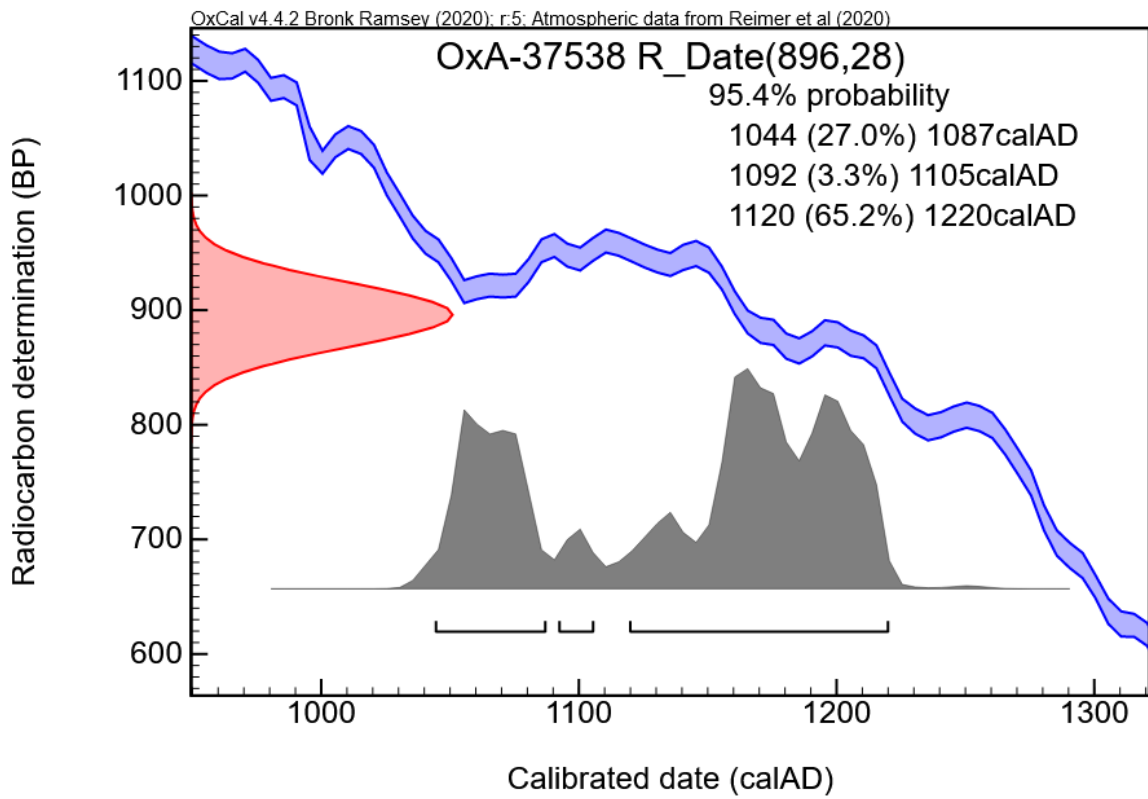
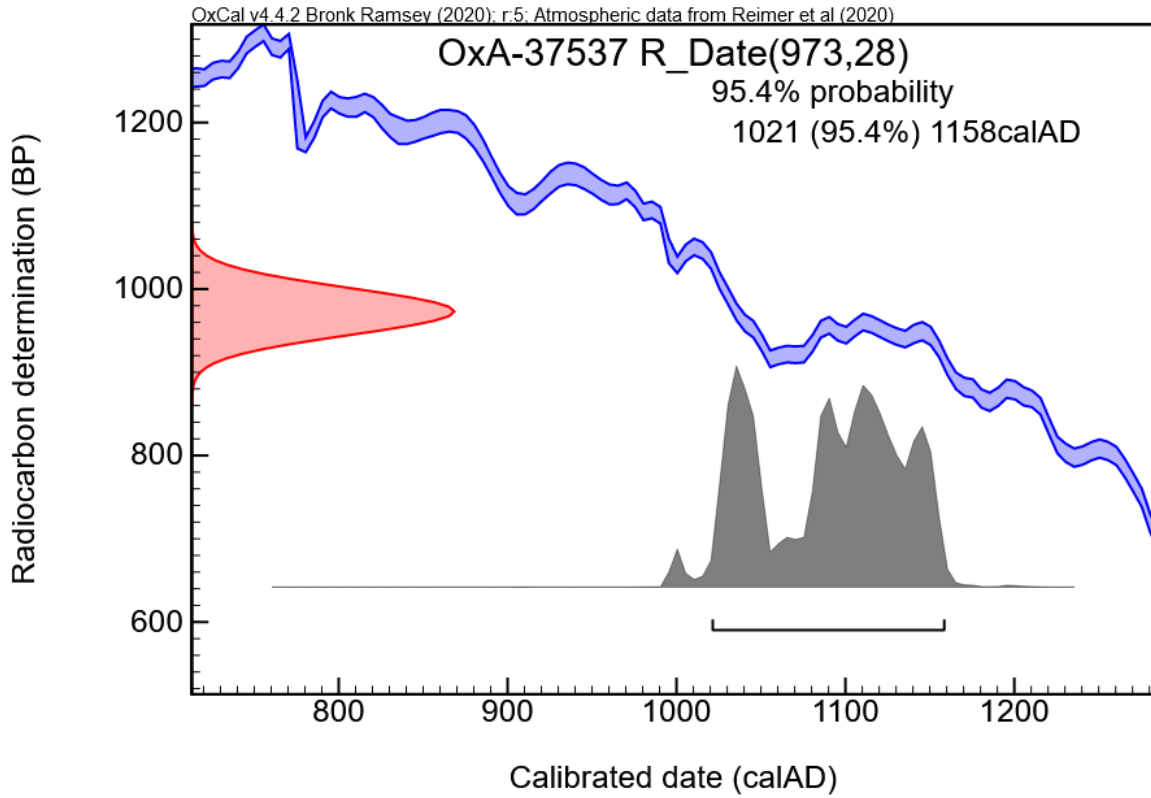
feature	context	grains	laboratory no.	age BP	calibrated years AD (confidence)
130	1682	3 x oats	OxA-37395	1111 ± 25	888–993 (95.4%)
585	2223	3 x oats	OxA-37533	930 ± 28	1033–1176 (94.8%)
136	2136	3 x oats	OxA-37534	1120 ± 27	880–995 (94.3%)
136	2134	3 x oats	OxA-37669	1076 ± 26	893–929 (26.7%), 944–1024 (68.7%)
(SFB)	1988	3 x free-threshing wheat	OxA-37535	910 ± 27	1041–1214 (95.5%)
			OxA-37536	888 ± 27	1122–1223 (73.2%)
449	2178	3 x rye	OxA-37537	973 ± 28	1021–1158 (95.4%)
471	1929	3 x free-threshing wheat	OxA-37538	896 ± 28	1044–1087 (27.0%), 1120–1220 (65.2%)
435	2102 066/077	3 x rye	OxA-37539	962 ± 27	1026–1158 (95.4%)
435	2102 066/079	3 x rye	OxA-37540	919 ± 26	1037–1180 (90.4%)
435	2102 069/078	3 x rye	OxA-37541	981 ± 27	1017–1054 (31.5%), 1063–1158 (61.5%)

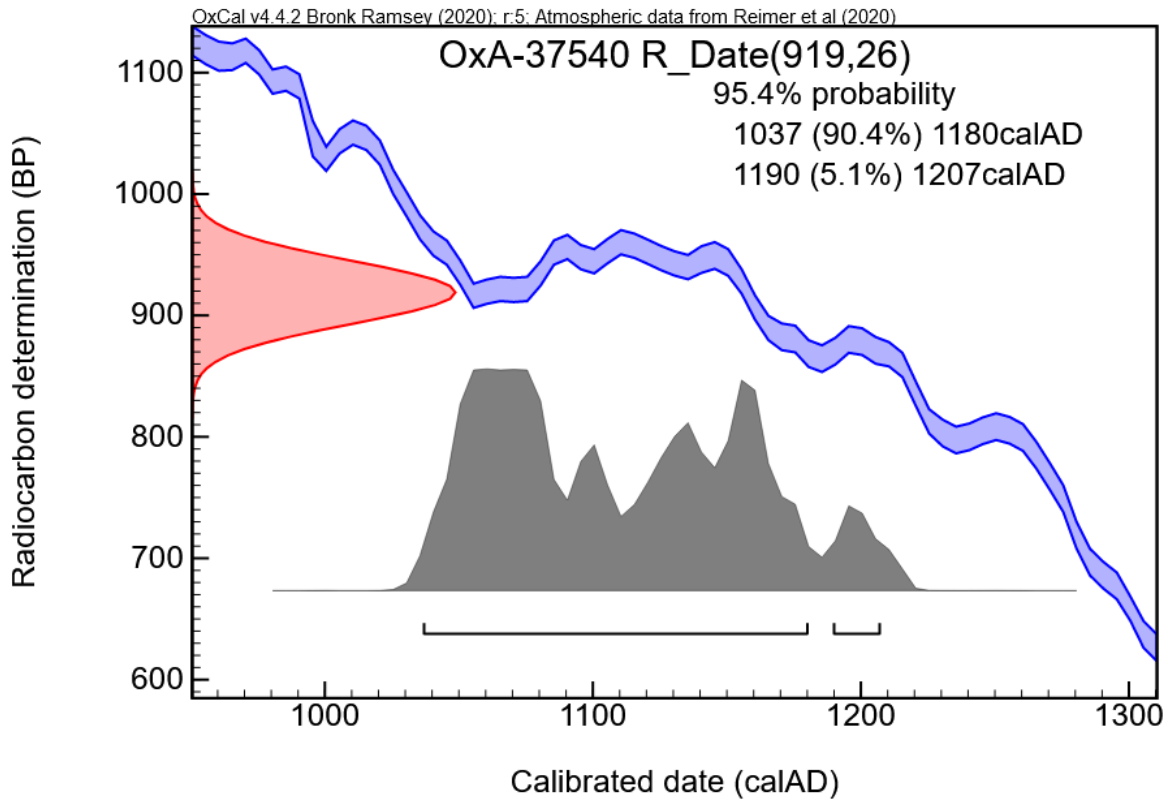
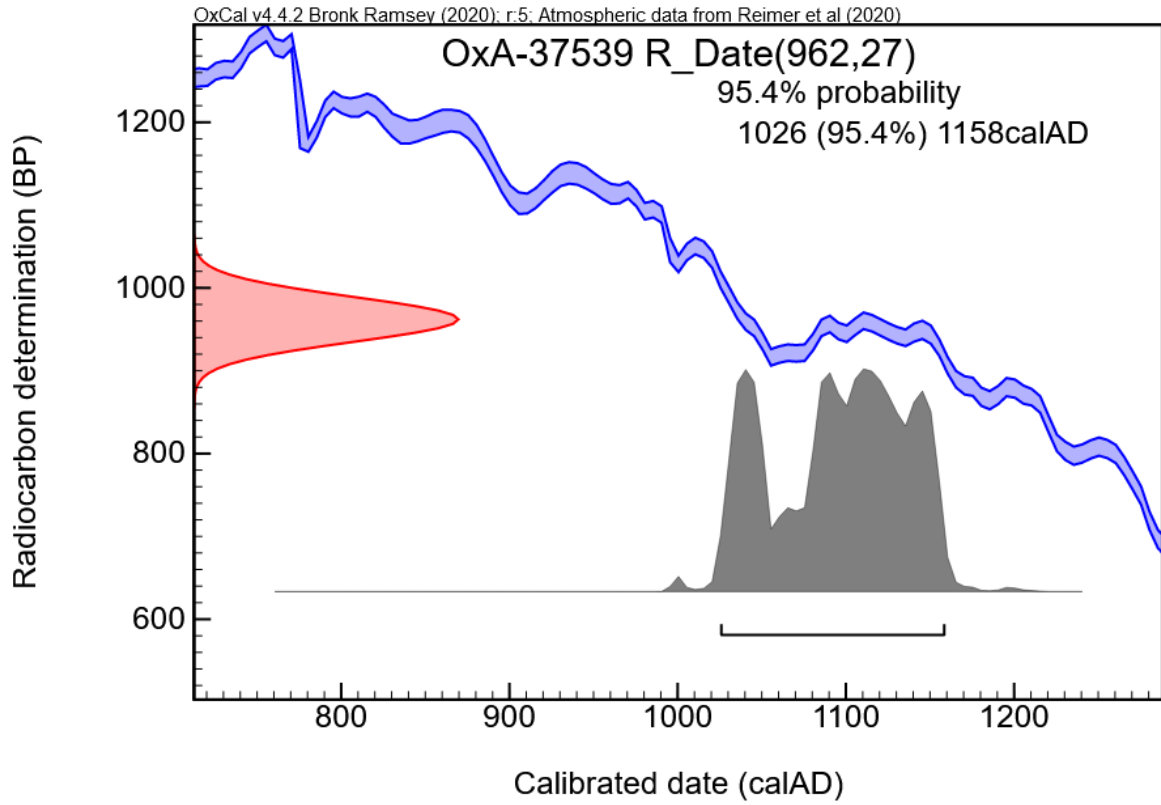


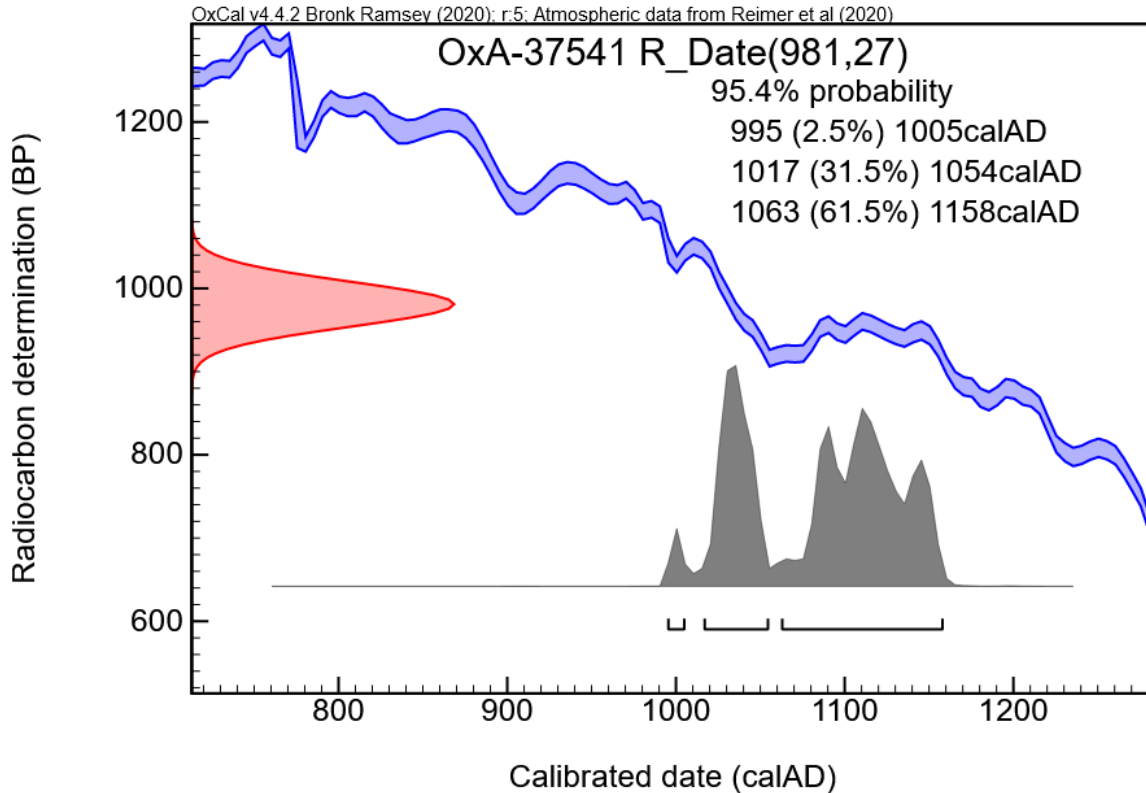












### *Modelling the dates*

The radiocarbon and other dates described above have been included in a Bayesian statistical model in OxCal 4.4.2 (Bronk Ramsey 2009), based upon the chronological framework for St Mary's Grove outlined above. The model used here employs an outlier model for the charcoal samples, allowing for the possibility of an 'old wood' effect. The model is presented below in CQL2 code, along with the results in tabular and graphic form.

This model suggests that activity at St Mary's Grove begins in the latter half of the tenth century with the ovens in the north-east area. Oven F585 appears to be the latest of the north-eastern oven group, returning a date around the middle of the eleventh century. Pit F449, which cuts this oven, is likely datable to the late eleventh or early twelfth century.

In the central area, Carver dated the SFB to the Late Saxon period, and likewise the charred grain in the backfill of the Norman quarry pit. The charred plant remains from all of these features have now returned mid-eleventh to mid-twelfth century dates, with generally higher probabilities around the middle or latter part of the eleventh century (a similar date-range is likely for the material in Pit F471, in the south-west area). The dates for the central area would be compatible with Carver's proposed conflagration around the time of the Norman Conquest, although it is alternatively possible that some or all of the material is of late eleventh to mid-twelfth century date – in which case, it would constitute unexpected evidence for bulk grain handling in the post-Conquest phase.



```
Plot()
{
  Outlier_Model("Charcoal",Exp(1,-10,0),U(0,3),"t");
  Sequence("St Marys Grove") {
    Boundary("Start whole");
    Phase("whole")
    {
      Phase("North-East area")
      {
        Sequence("ovens to pits sequence")
        {
          Boundary ("Start Period 3");
          Phase ("Period 3")
          {
            Phase("Oven F130")
            {
              R_Date("OxA-37395", 1111, 25);
            };
            Phase("Oven F584")
            {
              R_Date("HAR-7039", 1270, 70)
              {
                Outlier("Charcoal",1);
              };
              R_Date("HAR-7040", 1120, 70)
              {
                Outlier("Charcoal",1);
              };
              R_Date("HAR-7041", 1310, 90)
              {
                Outlier("Charcoal",1);
              };
            };
            Phase("Oven F585")
            {
              R_Date("OxA-37533", 930, 28);
            };
            Phase("Pit F136")
            {
              Sequence("F136 pit fills")
              {
                Boundary("Start 2136");
                Phase("context 2136")
                {
                  R_Date("OxA-37534", 1120, 27);
                };
                Boundary("end 2136 start 2134");
                Phase("context 2134")
                {
                  R_Date("OxA-37669", 1076, 26);
                };
                Boundary("end 2134");
              };
            };
            Boundary("end Period 3 start Period 4");
            Phase ("Period 4")
            {
              R_Date("OxA-37537", 973, 28);
            }
          }
        }
      }
    }
  }
}
```



```
};
Boundary("End Period 4");
};
};
Phase("Central area")
{
Phase("F517 SFB")
{
R_Date("OxA-37535", 910, 27);
R_Date("OxA-37536", 888, 27);
};
Phase("F435 quarry pit")
{
R_Date("OxA-37539", 962, 27);
R_Date("OxA-37540", 919, 26);
R_Date("OxA-37541", 981, 27);
};
};
Phase("South-West area")
{
Phase("F471")
{
R_Date("OxA-37538", 896, 28);
};
};
};
Boundary("End whole");
};
};
```



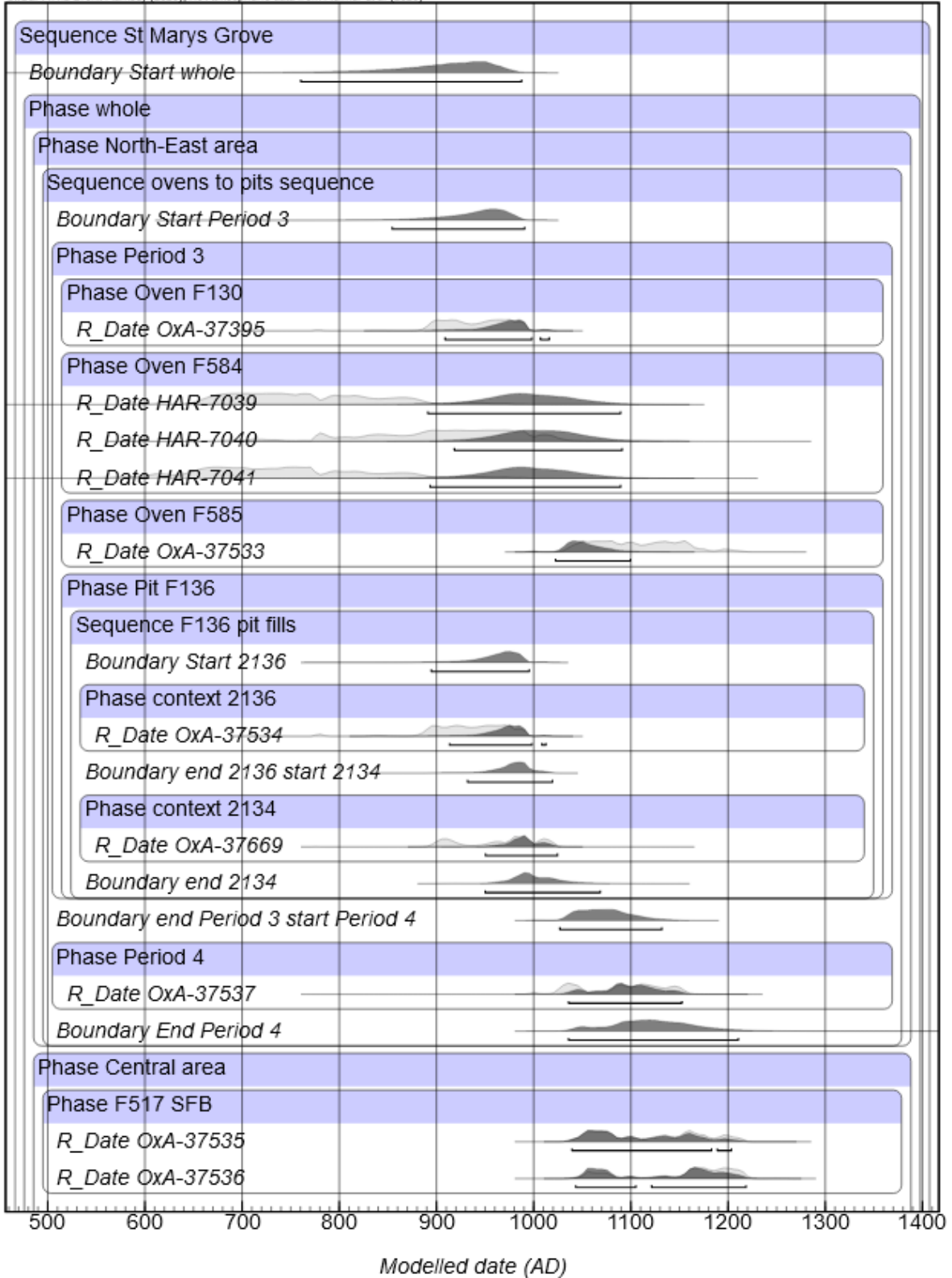
Name	Unmodelled (BC/AD)			Modelled (BC/AD)			Indices				Select	Page break				
	from	to	%	from	to	%	A <sub>model</sub> =91.7	A <sub>overall</sub> =90	A <sub>comb</sub>	A			L	P	C	
▼ Outlier_Model Charcoal				-342	3	95.4								99.6	<input checked="" type="checkbox"/> 44	<input type="checkbox"/>
Exp(1,-10,0)	-3.19	-0.05	95.4											99.6	<input checked="" type="checkbox"/> 2	<input type="checkbox"/>
U(0,3)	2.21177e-17	3	95.4	1.275	3	95.4		100						98.6	<input checked="" type="checkbox"/> 3	<input type="checkbox"/>
▼ Sequence St Marys Grove															<input checked="" type="checkbox"/> 4	<input type="checkbox"/>
Boundary Start whole				760	987	95.4								95.4	<input checked="" type="checkbox"/> 5	<input type="checkbox"/>
▼ Phase whole															<input checked="" type="checkbox"/> 6	<input type="checkbox"/>
▼ Phase North-East area															<input checked="" type="checkbox"/> 7	<input type="checkbox"/>
▼ Sequence ovens to pits sequence															<input checked="" type="checkbox"/> 8	<input type="checkbox"/>
Boundary Start Period 3				854	990	95.4								98.7	<input checked="" type="checkbox"/> 9	<input type="checkbox"/>
▼ Phase Period 3															<input checked="" type="checkbox"/> 10	<input type="checkbox"/>
▼ Phase Oven F130															<input checked="" type="checkbox"/> 11	<input type="checkbox"/>
R_Date OxA-37395	888	993	95.4	909	1016	95.4		99.5						99.3	<input checked="" type="checkbox"/> 12	<input type="checkbox"/>
▼ Phase Oven F584															<input checked="" type="checkbox"/> 13	<input type="checkbox"/>
R_Date HAR-7039	645	950	95.4	891	1089	95.4		82.7						99.3	<input checked="" type="checkbox"/> 14	<input type="checkbox"/>
R_Date HAR-7040	702	1038	95.4	918	1091	95.4		111.7						99.7	<input checked="" type="checkbox"/> 15	<input type="checkbox"/>
R_Date HAR-7041	577	951	95.4	893	1089	95.4		81.1						99.4	<input checked="" type="checkbox"/> 16	<input type="checkbox"/>
▼ Phase Oven F585															<input checked="" type="checkbox"/> 17	<input type="checkbox"/>
R_Date OxA-37533	1033	1198	95.4	1022	1099	95.4		91.6						99.7	<input checked="" type="checkbox"/> 18	<input type="checkbox"/>
▼ Phase Pit F136															<input checked="" type="checkbox"/> 19	<input type="checkbox"/>
▼ Sequence F136 pit fills															<input checked="" type="checkbox"/> 20	<input type="checkbox"/>
Boundary Start 2136				894	995	95.4								99	<input checked="" type="checkbox"/> 21	<input type="checkbox"/>
▼ Phase context 2136															<input checked="" type="checkbox"/> 22	<input type="checkbox"/>
R_Date OxA-37534	775	995	95.4	913	1012	95.4		98						99.2	<input checked="" type="checkbox"/> 23	<input type="checkbox"/>
Boundary end 2136 start 2134				932	1019	95.4								99.3	<input checked="" type="checkbox"/> 24	<input type="checkbox"/>
▼ Phase context 2134															<input checked="" type="checkbox"/> 25	<input type="checkbox"/>
R_Date OxA-37669	893	1024	95.4	950	1024	95.4		115						99.5	<input checked="" type="checkbox"/> 26	<input type="checkbox"/>
Boundary end 2134				950	1068	95.4								99.6	<input checked="" type="checkbox"/> 27	<input type="checkbox"/>
Boundary end Period 3 start Period 4				1027	1132	95.4								99.6	<input checked="" type="checkbox"/> 28	<input type="checkbox"/>
▼ Phase Period 4															<input checked="" type="checkbox"/> 29	<input type="checkbox"/>
R_Date OxA-37537	1021	1158	95.4	1036	1152	95.4		97.8						99.6	<input checked="" type="checkbox"/> 30	<input type="checkbox"/>
Boundary End Period 4				1036	1210	95.4								99.5	<input checked="" type="checkbox"/> 31	<input type="checkbox"/>



▼ Phase Central area	☰											<input checked="" type="checkbox"/> 32	<input type="checkbox"/>
▼ Phase F517 SFB	☰											<input checked="" type="checkbox"/> 33	<input type="checkbox"/>
R_Date OxA-37535	☰	1041	1214	95.4	1039	1203	95.4		102.4		99.7	<input checked="" type="checkbox"/> 34	<input type="checkbox"/>
R_Date OxA-37536	☰	1046	1223	95.4	1043	1218	95.4		89		99.5	<input checked="" type="checkbox"/> 35	<input type="checkbox"/>
▼ Phase F435 quarry pit	☰											<input checked="" type="checkbox"/> 36	<input type="checkbox"/>
R_Date OxA-37539	☰	1026	1158	95.4	1026	1156	95.4		99.4		99.8	<input checked="" type="checkbox"/> 37	<input type="checkbox"/>
R_Date OxA-37540	☰	1037	1207	95.4	1035	1200	95.4		103		99.8	<input checked="" type="checkbox"/> 38	<input type="checkbox"/>
R_Date OxA-37541	☰	995	1158	95.4	996	1157	95.4		99.6		99.8	<input checked="" type="checkbox"/> 39	<input type="checkbox"/>
▼ Phase South-West area	☰											<input checked="" type="checkbox"/> 40	<input type="checkbox"/>
▼ Phase F471	☰											<input checked="" type="checkbox"/> 41	<input type="checkbox"/>
R_Date OxA-37538	☰	1044	1220	95.4	1042	1215	95.4		95.1		99.5	<input checked="" type="checkbox"/> 42	<input type="checkbox"/>
Boundary End whole	☰				1083	1335	95.4				98.7	<input checked="" type="checkbox"/> 43	<input type="checkbox"/>



OxCal v4.4.2 Bronk Ramsey (2020); r.5 Atmospheric data from Reimer et al (2020)



## Bath Street

### *The settlement sequence*

The Bath Street site lay immediately to the west of the St Mary's Grove excavations, at the highest point of the town (Carver 2010, 37). The chronology of the site had to be established principally by ceramic dates: 'The main problem in establishing a sequence was either that there was no stratification, or that what there was had been truncated... the phasing was thus dependent on the presence or absence of Stafford ware, medieval and post-medieval pottery, all easily distinguishable. The seriation showed that occupation was more or less continuous, with some features, notably ditch F92, remaining open over a long period' (Carver 2010, 37).

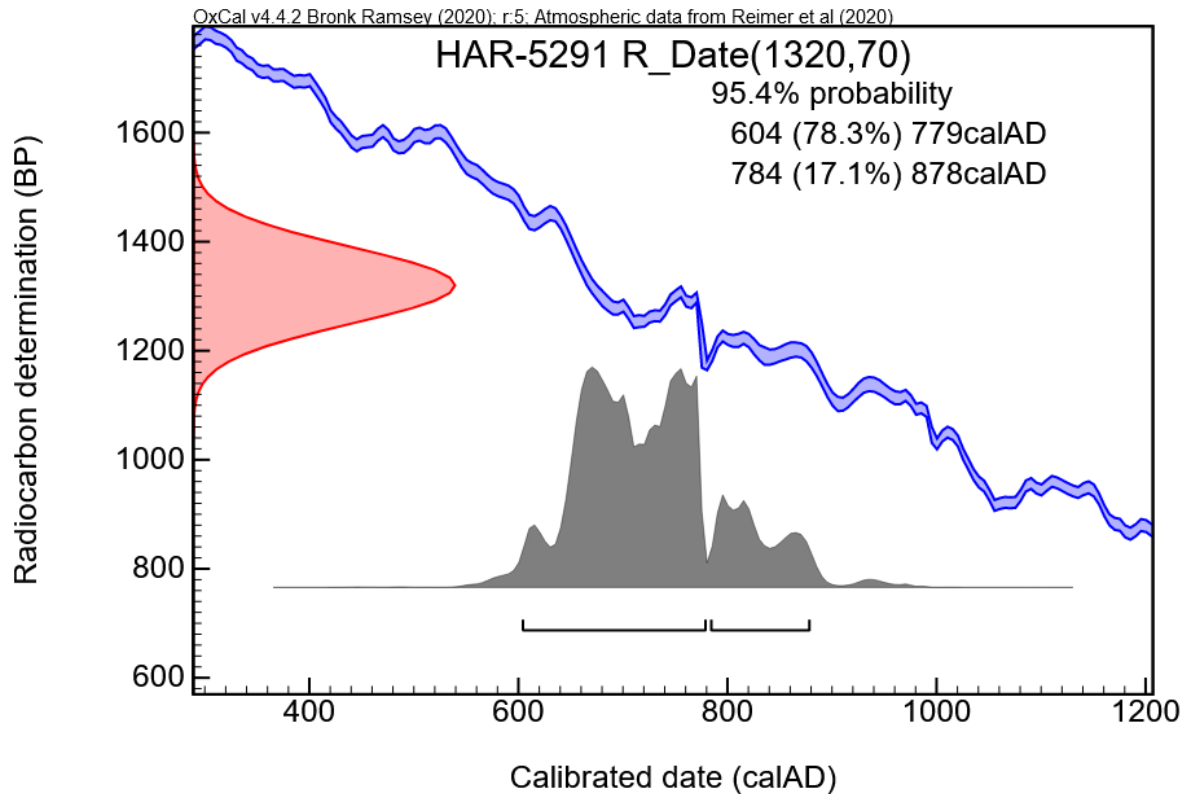
Carver (2010, 39) thus identified three periods of occupation: 'In PERIOD 1 (tenth–eleventh centuries), there was a structure involving smithying and using Stafford ware. A boundary, perhaps consisting of palisade and ditch, ran north-south along the western edge of the site, the eastern edge of what would become Earl Street. In PERIOD 2 (twelfth–fifteenth centuries), the basic geography is given by gullies and post-holes to the west and pits to the east. The pits are notably constrained in the south-east corner, which implies that Earl Street is still the frontage. The blank space implies that there was probably a timber-frame building with soak-away between the pit group and Earl Street. In PERIOD 3 (sixteenth–twentieth centuries), the few post-holes, the cultivation marks, the drains and the well strongly suggest a post-medieval garden'.

Of Bath Street, Moffett records that 'all of the contexts were sampled for charred remains' (1987, 2), but archaeobotanical remains are reported from only one feature, Pit 227, a large pit at the western edge of the excavated area, dated to PERIOD 2 by its latest (medieval) pottery. Moffett described the pit as containing 'several spreads and lenses of charred material' of which 'the larger spreads near the bottom were sampled and found to be very rich in charred grain' (1987, 16).

### *Earlier scientific dating evidence*

A single radiocarbon date was obtained for the Bath Street excavations, on charcoal from posthole F58, assigned to PERIOD 1. Of the original calibrated ( $2\sigma$ ) date range of cal. AD 600–808, Carver wrote: 'While certainly Anglo-Saxon, the presence in the sample of oak heartwood raises doubts that its deposition was that early' (2010, 39). Using IntCal20 (Reimer *et al.* 2020) and OxCal 4.4.2 (Bronk Ramsey 2009), the date can be recalibrated as follows.

feature	context	material	laboratory no.	age BP	calibrated date AD (confidence)
Posthole F58	1082	charcoal (oak heartwood and hazel)	HAR-5291	1320 ± 70	604–779 (78.3%), 784–878 (17.1%)



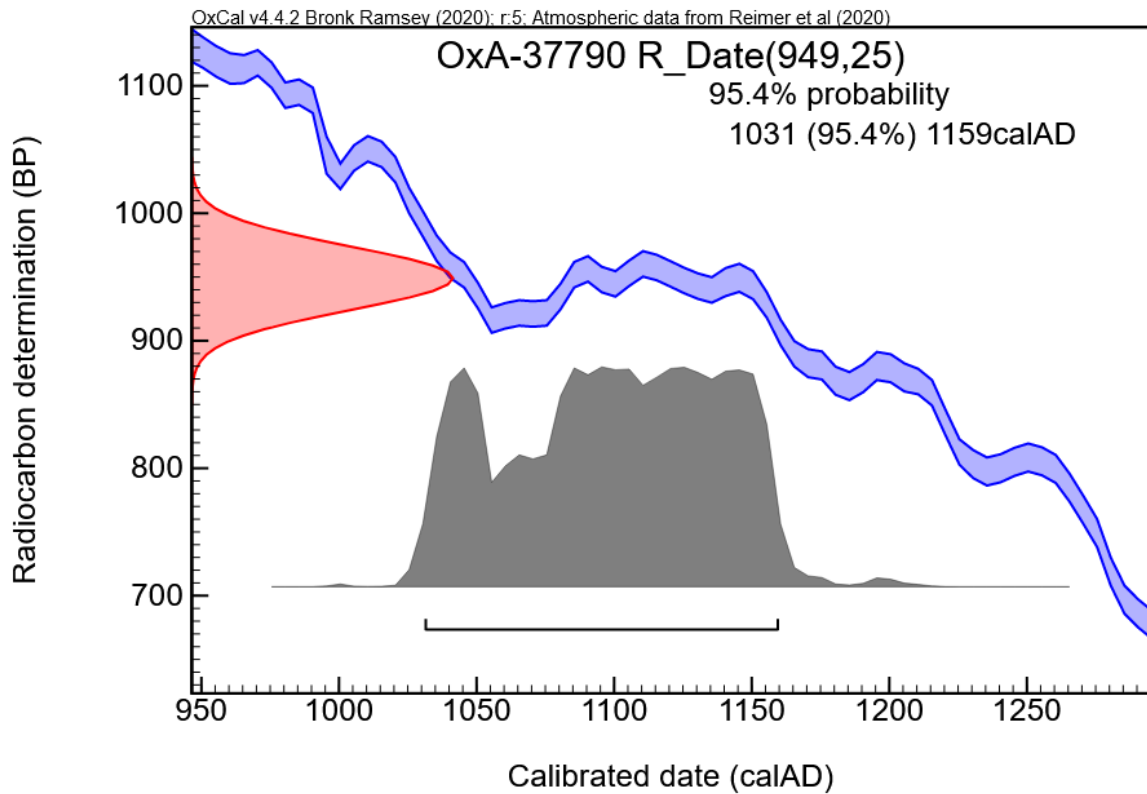
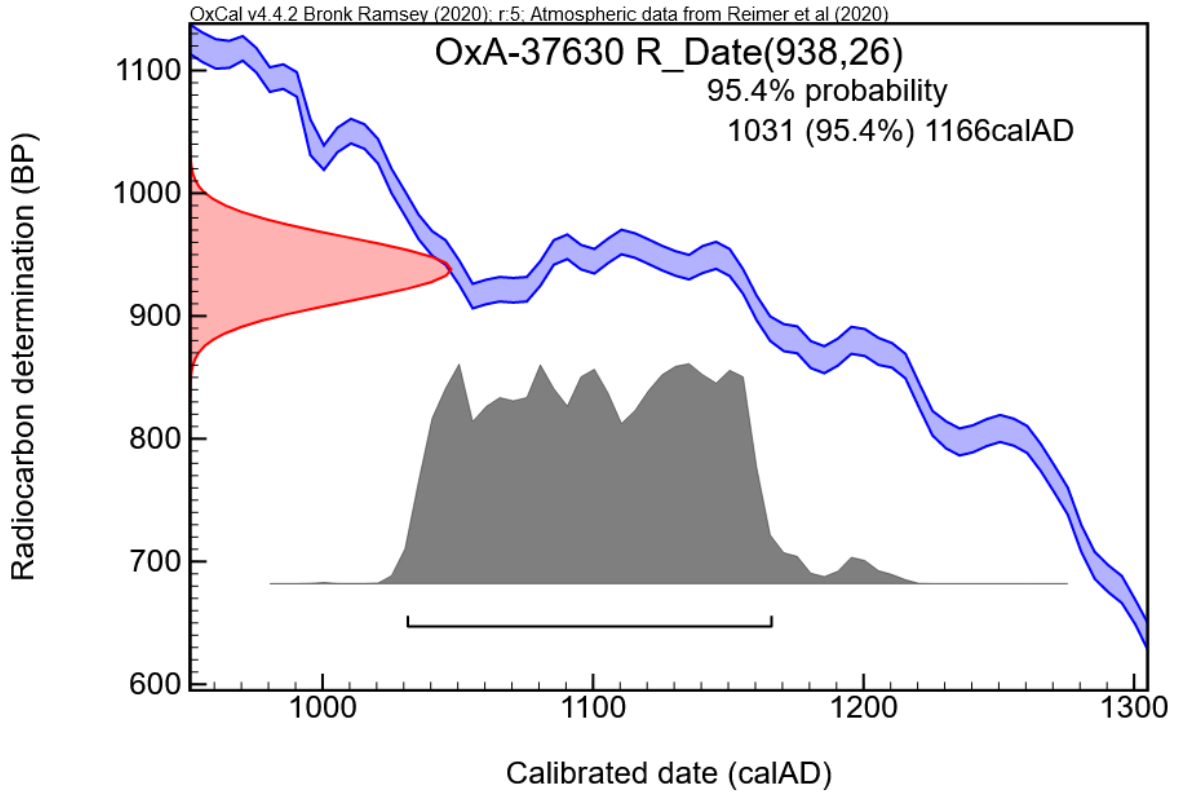
### *New radiocarbon dates*

As part of the FeedSax project, charred grain samples from two contexts from Pit F227 were submitted to the Oxford Radiocarbon Accelerator Unit for radiocarbon dating. Working from the contextual information available at the time of writing, there is no reason to believe that the two samples are not closely contemporary, and the radiocarbon dates are compatible with this assumption. Calibrations of the FeedSax radiocarbon results, using IntCal20 and conducted using OxCal 4.4.2 (Bronk Ramsey 2009), are given below.

feature	context	sample	grains	laboratory no.	age BP	calibrated date AD (confidence)
Pit F227	1069B	IIB	3 x rye	OxA-37630	938 ± 26	1031–1166 (95.4%)
Pit F227	1071A	IA	3 x rye	OxA-37790	949 ± 25	1031–1159 (95.4%)

The calibrated date ranges of these two samples together suggest the material dates from between *circa* 1030 and 1160, a somewhat earlier date than that ascribed by Carver.

Since there are so few radiocarbon dates, two of them with near-identical date-ranges and no known stratigraphic relationships between them, there was little to be gained by Bayesian modelling for this site. It is probable that the charred plant remains Pit F227 all date from between *circa* AD 1030 and 1160.



## Tipping Street

### *The settlement sequence*

The Tipping Street excavations by Oxford Archaeology spanned four different areas and identified seven occupation phases, defined initially by a combination of ceramic dating and stratigraphy (Dodd *et al.* 2013):

- Phase 1: Prehistoric (possibly Iron Age)
- Phase 2: Late Saxon (ninth to early eleventh century)
- Phase 3: Later eleventh to twelfth century
- Phase 4: Thirteenth to mid-fourteenth century
- Phase 5: Late fourteenth to sixteenth century
- Phase 6: Seventeenth to mid-eighteenth century
- Phase 7: Later eighteenth century and later

The Late Saxon phase (2) was the main focus of the post-excavation analysis, because of both the high quality of the excavated evidence and the potentially wide significance of dating and contextualising the origins and development of Stafford Ware and the Late Saxon *burh* (Dodd *et al.* 2013, 10). This focus is reflected in the archaeobotanical work. Of the 11 samples subjected to full analysis of charred plant remains, one was from Phase 1, nine were from Phase 2, and one was from Phase 4 (Druce in Dodd *et al.* 2013).

#### ***Phase 1***

The features assigned to Phase 1 produced no directly dated evidence, but were stratigraphically earlier than the earliest identified Late Saxon evidence. They comprise curvilinear gullies which ‘could be roundhouse drip gullies or wall trenches of Iron Age or earlier date’ (Dodd *et al.* 2013, 11), and a buried build-up of sandy soils whose relationship to the curvilinear gullies was unclear. The only finds from these soils were an undiagnostic struck flint from the earliest layer (2114), and ‘two Stafford-type ware sherds from layer 2103 which are likely to be intrusive since tree roots had heavily disturbed this deposit’ (*ibid.*, 12). It is the earliest of these layers (2114) from which charred plant remains were recovered and analysed (sample 115).

#### ***Phase 2***

Activity in Phase 2 was chiefly characterised by ‘three *in situ* kiln bases and a large quantity of demolished kiln debris... all associated with the Stafford-type ware pottery industry’ (*ibid.*, 13). Two of the kilns were situated in Area 3. Kiln 3408 was the earlier kiln; samples 205 and 221 both derive from context 3203 (in stoke pit 3202), while sample 204 comes from context 3205, ‘overlying the demolition and trample layers of kiln 3408’ (*ibid.*, 19). Two other contexts, representing the base of the kiln, deserve mention since, although they have not produced charred plant remains, they were subject to archaeomagnetic dating to establish the last firing date of the kiln: contexts 3403 and 3404. Directly overlying this earlier kiln 3408 was the later kiln 3401, from whose floor (context 3201) comes sample 203, which perhaps represents the kiln’s last firing. Elsewhere in Area 3, two gullies and three pits, ‘some of which may pre-date the building of the first kiln’ (*ibid.*, 13), contained some Stafford-type ware sherds and were assigned to Phase 2.

The third kiln, 4287, was excavated in Area 4 ‘under watching brief conditions’ (*ibid.*, 13). Sample 405 comes from context 4306, the base of the kiln, while sample 404 comes from context 4305, a deposit associated with the demolition of the kiln. Sample 406 derives from context 4319, a pit

identified as a stokehole, much of whose contents is thought to represent ‘rake-out cinders during the use of the kiln, with a smaller proportion of demolition debris and dumped pottery’ (ibid., 25). Contexts 4304 and 4338 each produced a sample associated with the use of the kiln (403 and 407 respectively) which, although not analysed for charred plant remains, were radiocarbon dated as part of the original post-excavation analysis (see below). A timber-lined well, 4330, in Area 4 contained Stafford-type ware sherds and is also assigned to the Late Saxon phase; sample 412 comes from context 4339 in this feature.

In Area 2, ‘the presence of a large dump of demolished kiln debris in pit 2052’ (ibid., 13) suggests that a fourth kiln may have been situated nearby, either outside the excavated area, or else truncated by a medieval ditch. Also in Area 2 is ‘a probable hollow-way running from west to east’ which also belongs to this Late Saxon phase (ibid., 13).

Finally, Late Saxon features in Area 1 comprise ‘a single pit and a single wattle-lined well’ (ibid., 13). Sample 11 comes from context 381 in the pit 366, a feature characterised by layers of refuse containing much Stafford-type ware pottery and iron-working waste.

### ***Phase 3***

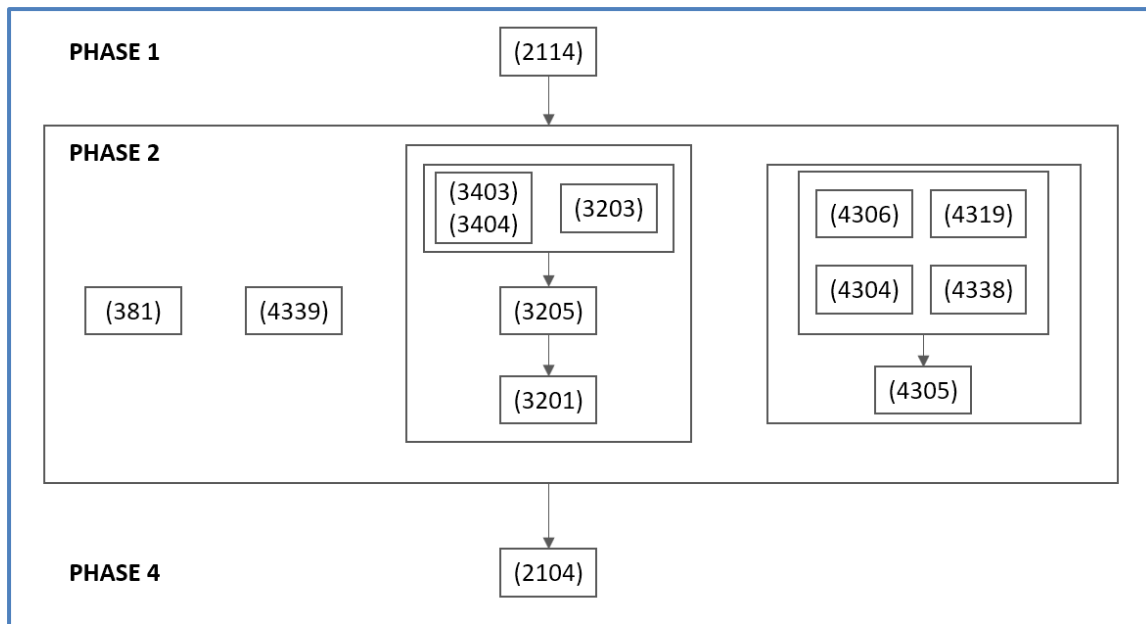
None of the samples fully analysed for charred plant remains are dated to Phase 3. In brief, the structural evidence from this phase comprised ‘at least two possible post-built structures... both of which stratigraphically post-date features containing Stafford-type ware pottery’ (ibid., 30).

### ***Phase 4***

In Area 2, a large ditch (feature 2106) ‘cut across possible hollow-way 2154 and clipped the eastern side of pit 2126... and was itself sealed by post-medieval garden soil 2108’ (ibid., 33). From context 2104, ‘a thin, charcoal-rich, silty sand’ in the fill of this ditch (ibid., 33), comes sample 118, as well as sherds of a Midlands white ware jug dating from the thirteenth to fourteenth centuries. Otherwise this phase was characterised by several pits, a well, and ‘a substantial post-built structure’ in Area 1 (ibid., 34).

### ***Summary***

The settlement sequence above, based largely upon stratigraphy and ceramics, allows us to construct a framework for the dating of these contexts. This framework has been designed as a basis for Bayesian modelling of dates. Hence the stratigraphic ordering is the opposite of that in a Harris matrix: the earliest context is at the top of the diagram and the latest context is at the bottom. Stratigraphic relationships are illustrated by arrows, which point from earlier to later (e.g. context 3201 is later than 3205).

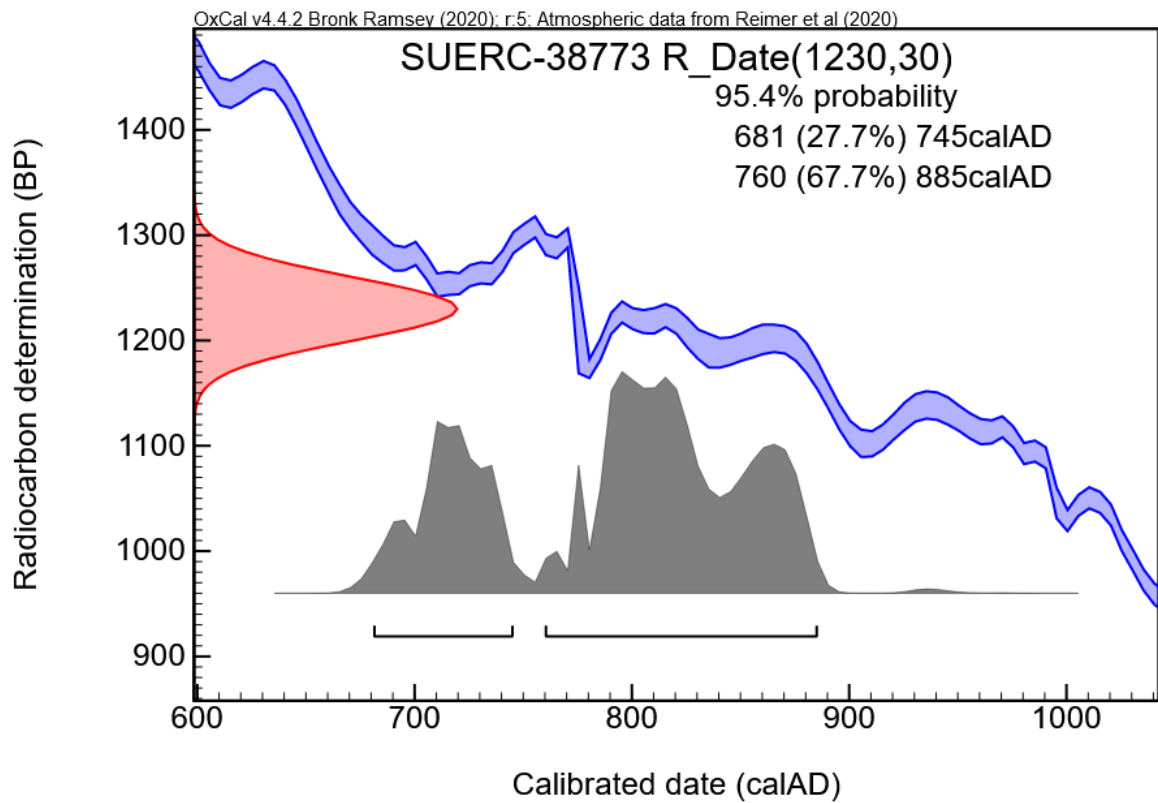
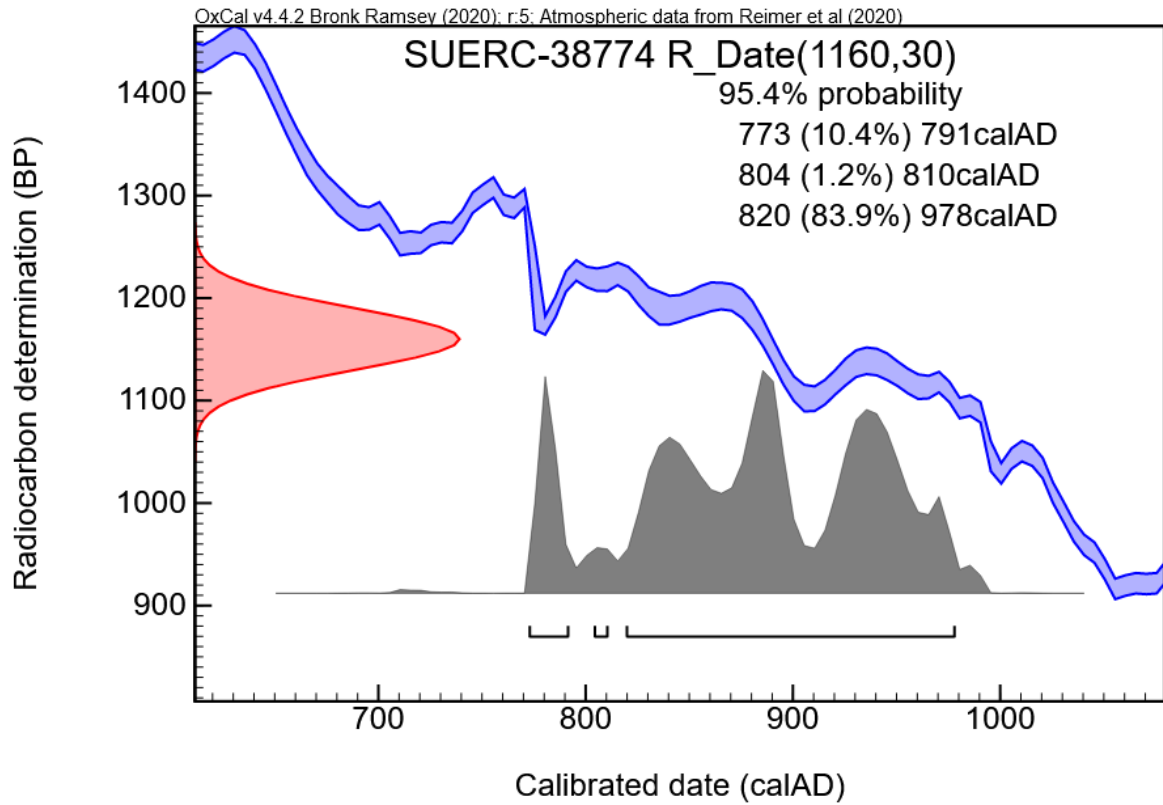


### Earlier scientific dating evidence

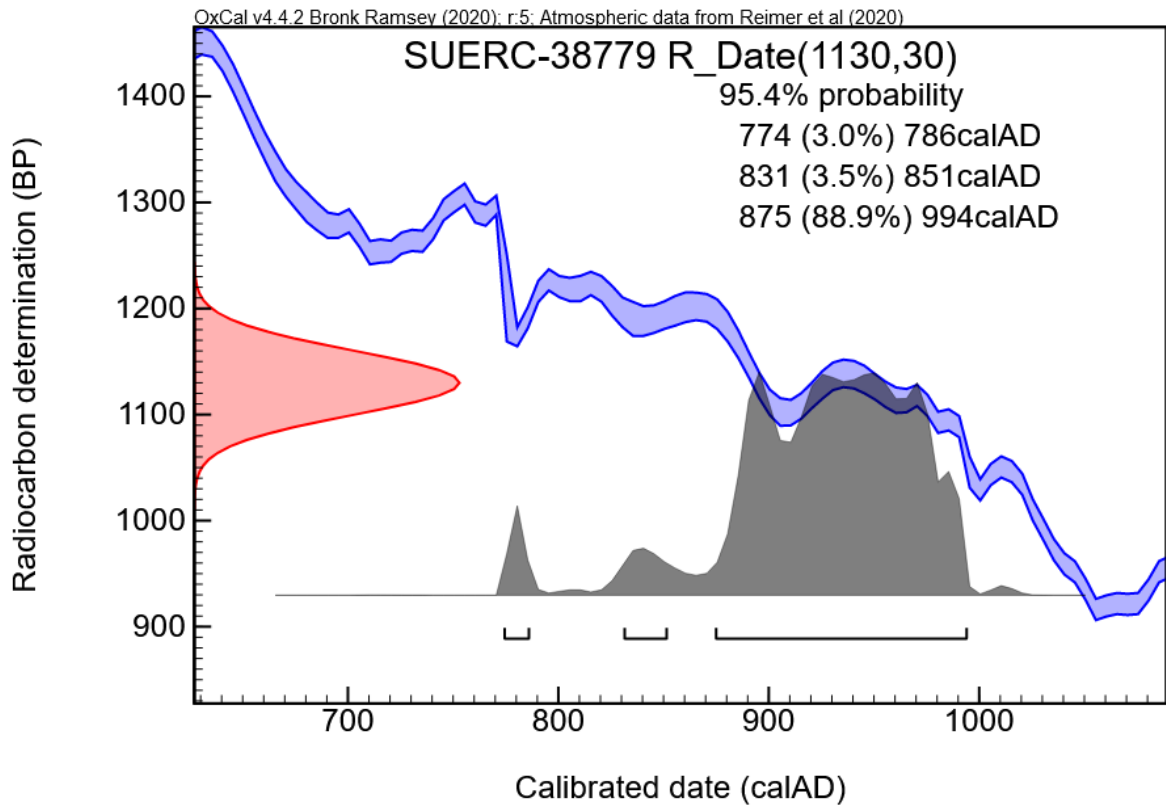
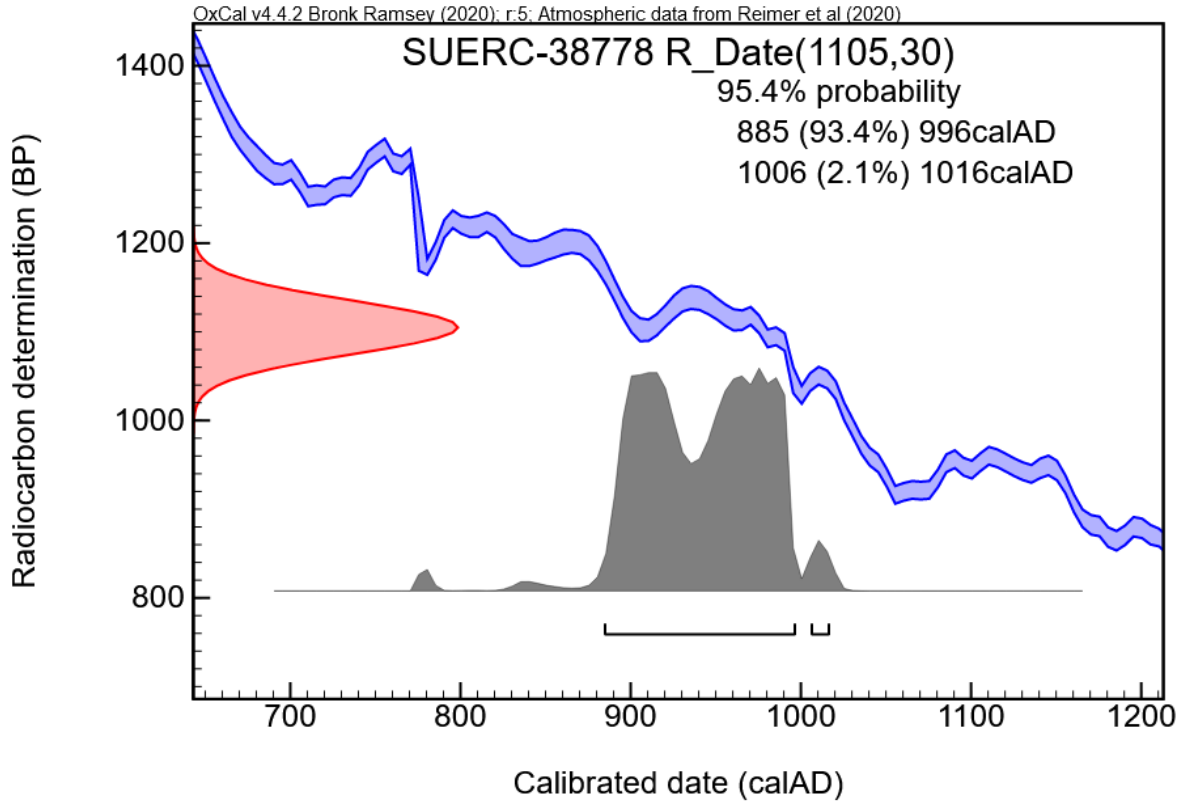
Oxford Archaeology obtained six radiocarbon dates from four environmental samples, all from contexts associated with the kilns, as follows:

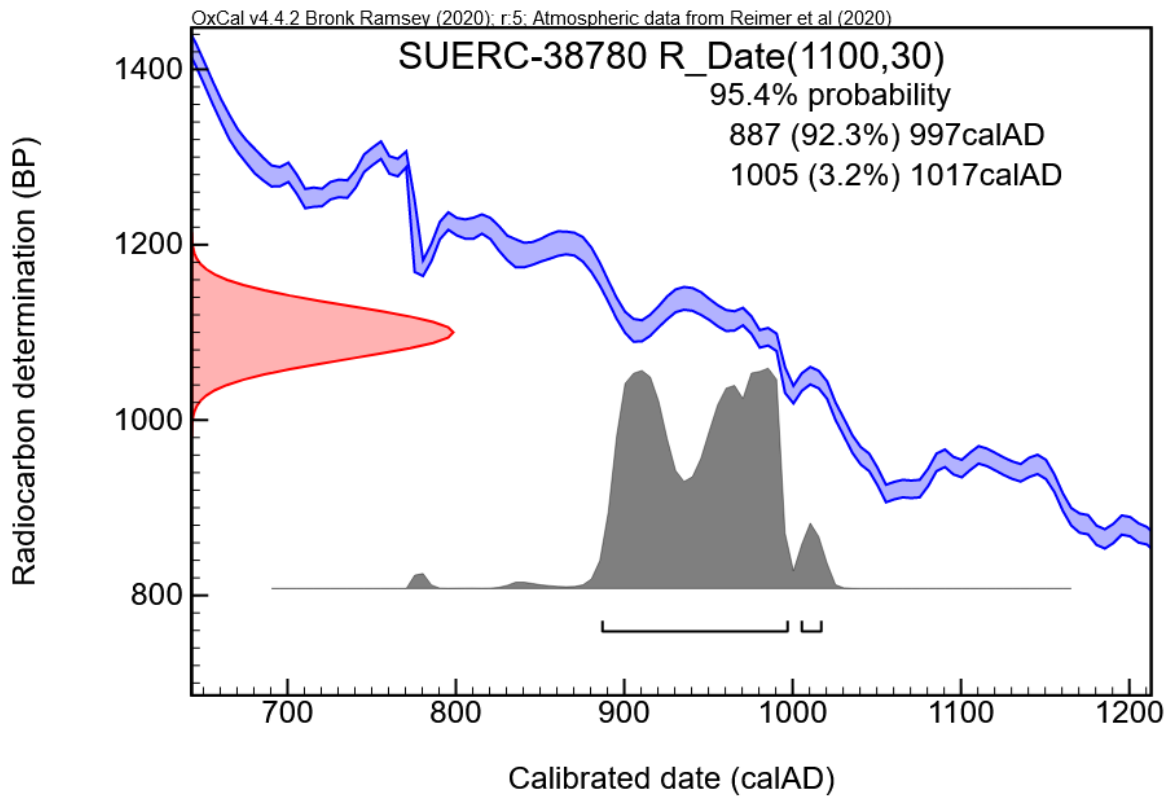
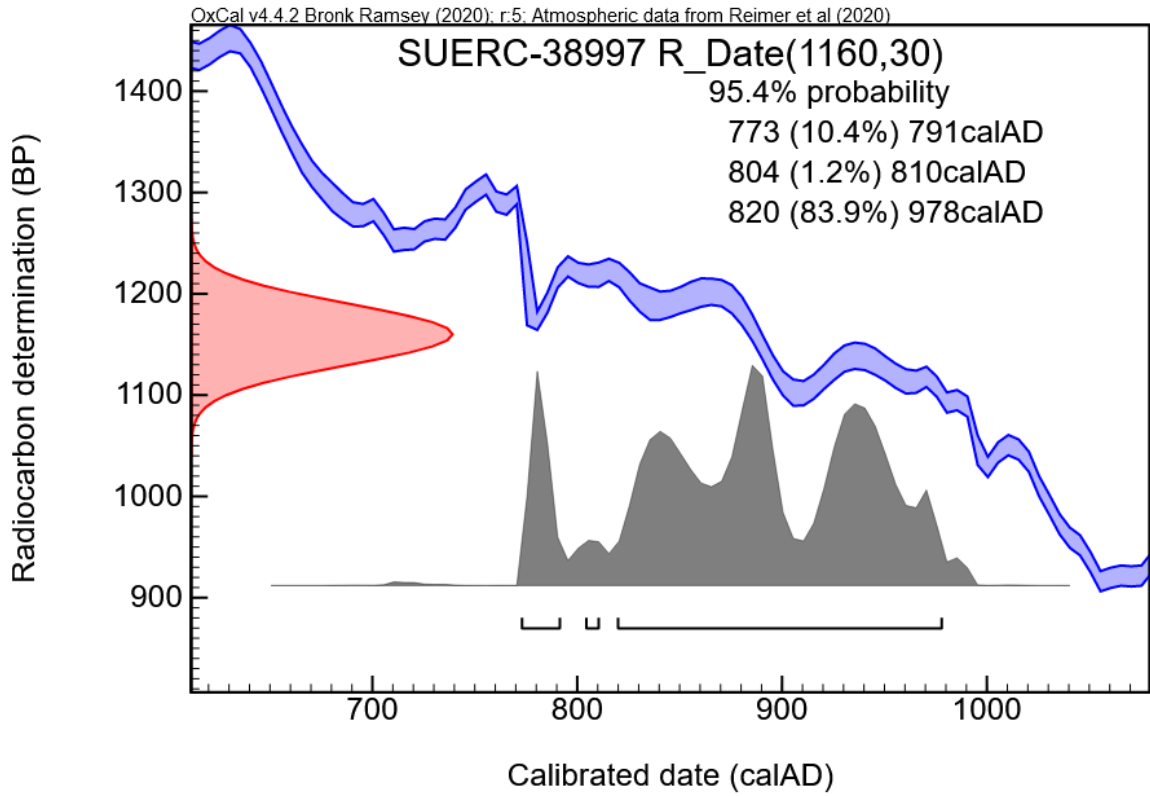
feature	context	sample	material	laboratory no.	age BP	calibrated date AD (confidence)
Kiln 3408	3203	205	<i>Triticum</i> sp. grain	SUERC-38774	1160 ± 30	820–978 (83.9%)
			<i>Alnus glutinosa</i> charcoal fragment	SUERC-38773	1230 ± 30	681–745 (27.7%), 760–885 (67.7%)
Kiln 4301	3201	203	<i>Triticum</i> sp. grain	SUERC-38778	1105 ± 30	885–996 (93.4%)
			<i>Corylus avellana</i> charcoal fragment	SUERC-38779	1130 ± 30	875–994 (88.9%)
Kiln 4287	4338	407	<i>Triticum</i> sp. grain	SUERC-38997	1160 ± 30	820–978 (83.9%)
	4304	403	<i>Triticum</i> sp. grain	SUERC-38780	1100 ± 30	887–997 (92.3%)

These results were originally calibrated, individually and as part of a Bayesian modelling exercise, using the IntCal09 calibration curve (Reimer *et al.* 2009). The calibration curve has since been updated and this report therefore uses IntCal20, the most recently published curve at the time of writing (Reimer *et al.* 2020). Revised calibrations of Oxford Archaeology’s radiocarbon results, using IntCal20 and conducted using OxCal 4.4.2 (Bronk Ramsey 2009), are given in the figures below and the table above.









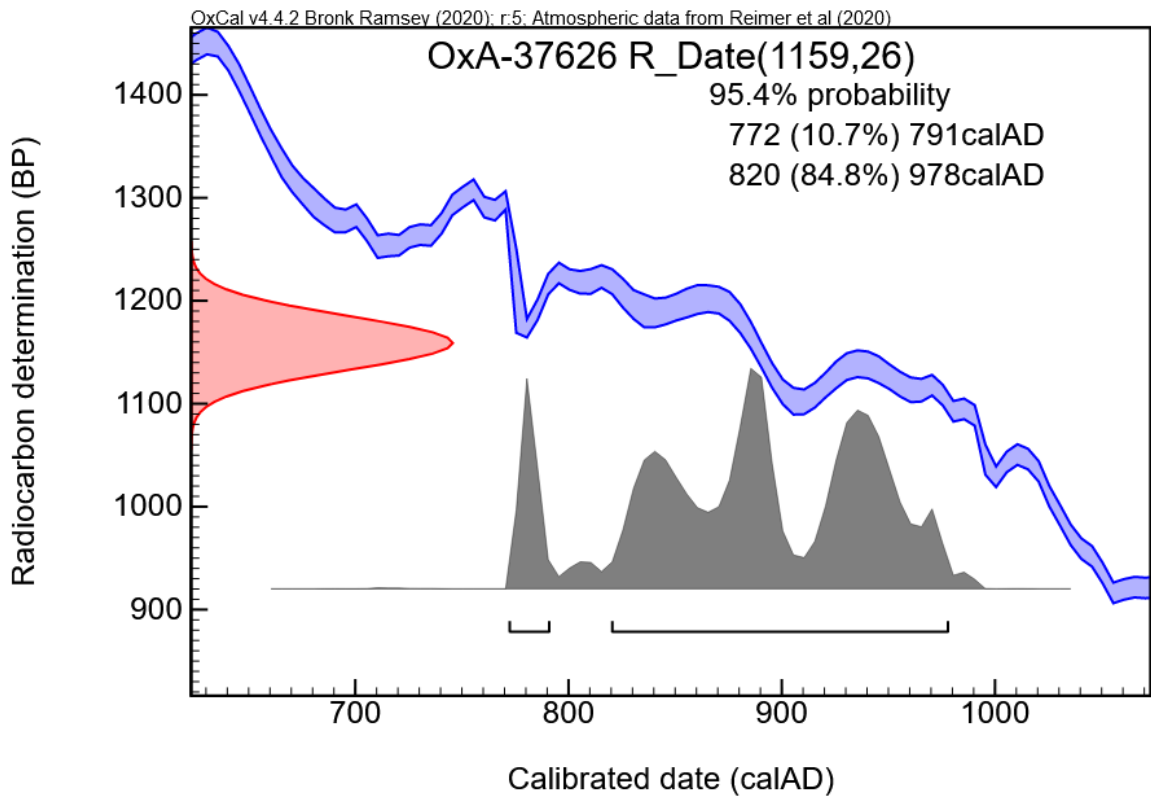
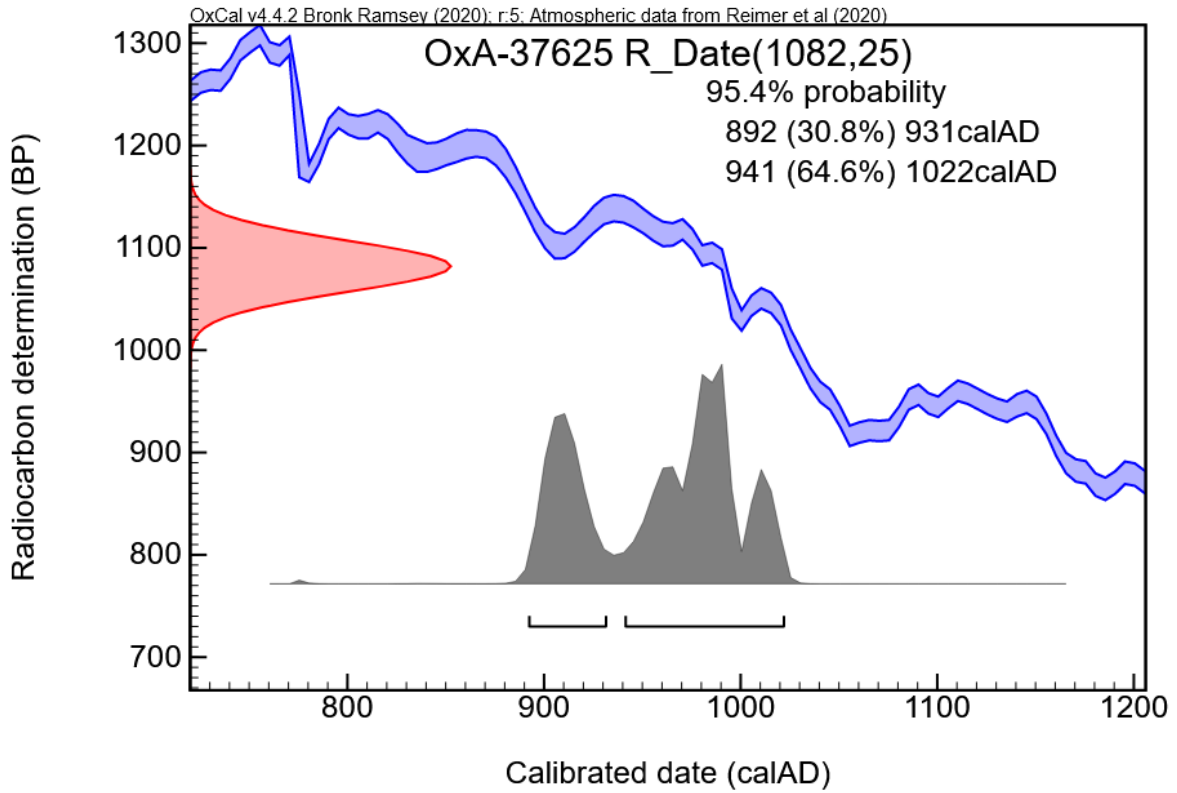
In addition to the radiocarbon dating programme, Oxford Archaeology obtained an archaeomagnetic date from 33 samples across three areas (contexts 3403 and 3404) in the feature group of kiln 3408, ‘intended to date the last firing of this feature’ (Dodd *et al.* 2013, 79), but the poor agreement between the archaeomagnetic and radiocarbon results led them to exclude the archaeomagnetic date from the chronometric model (*ibid.*, 82–83).

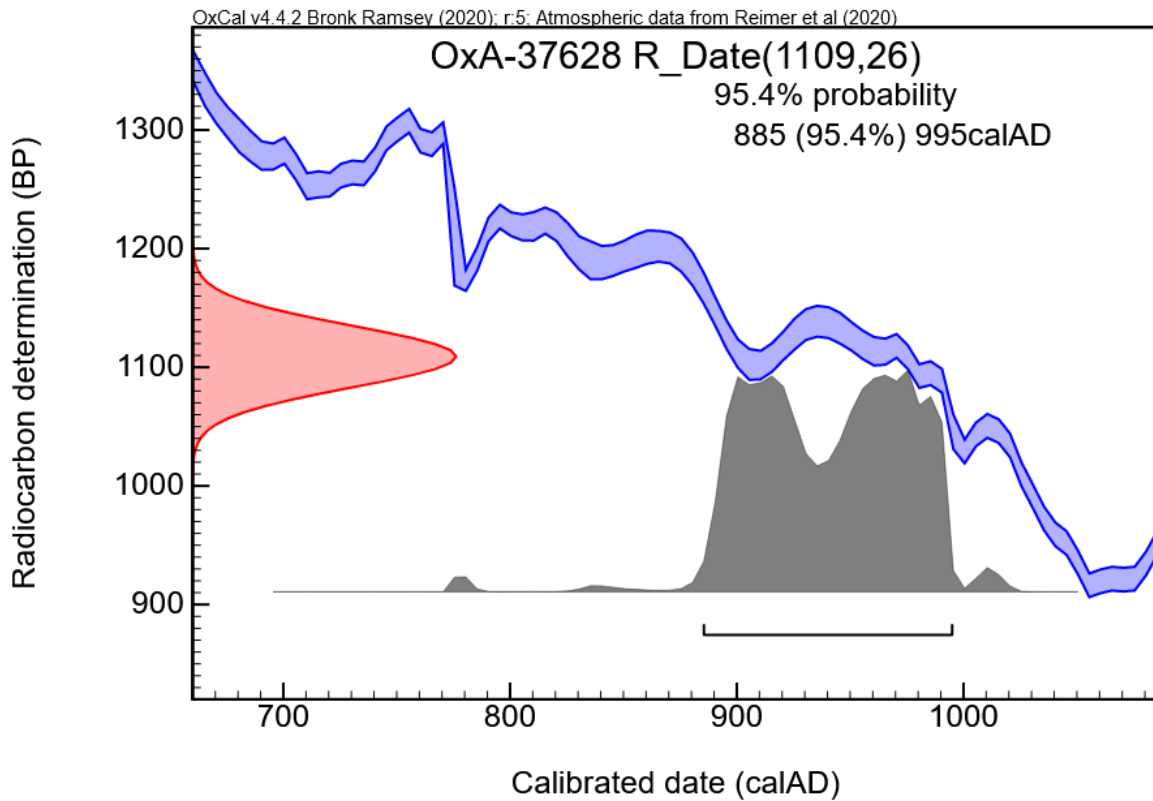
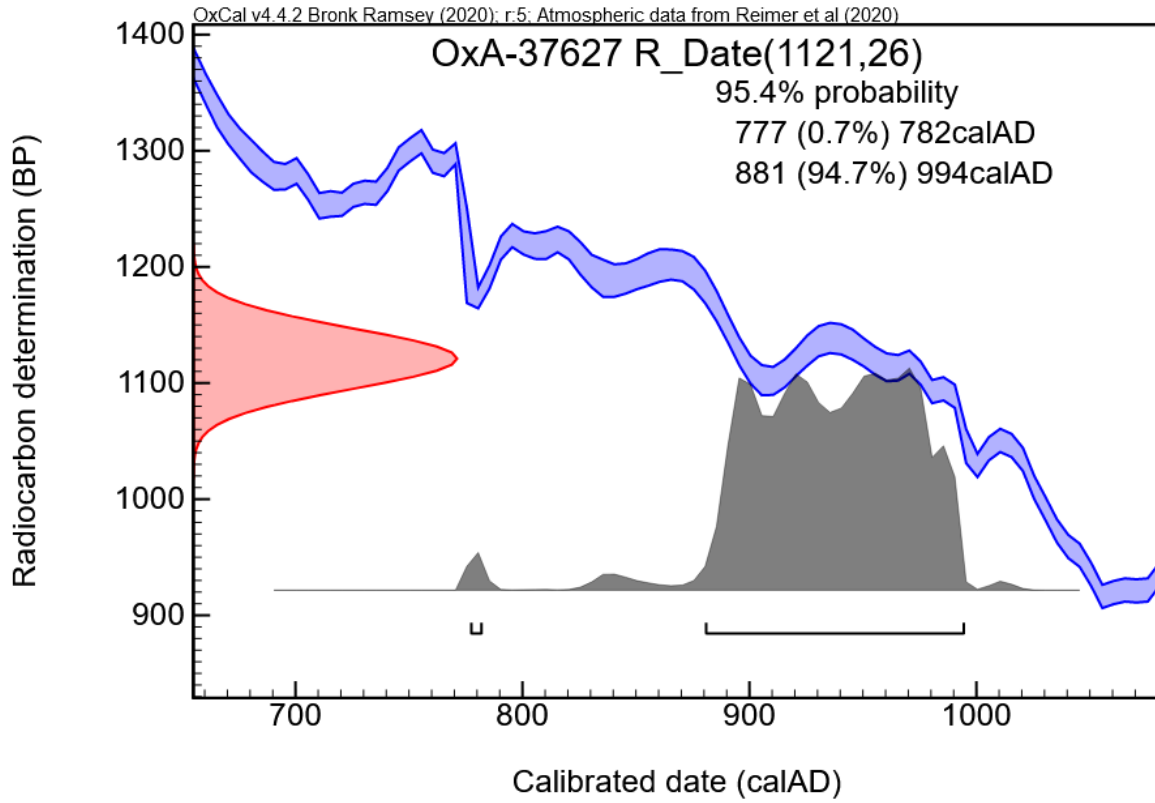
The Bayesian model thus produced by Oxford Archaeology estimated as follows: ‘the start of kiln use at the Tipping Street site in... probably *cal AD 790–890 (68.2%)* ... the estimate for the end of use of kilns at the Tipping Street site is... probably *cal AD 900–990 (68.2% probable)* ... It is highly probable (*98.8% probable*) that the activity at the site began before the establishment of the *burh* in AD 913...’ (*ibid.*, 83).

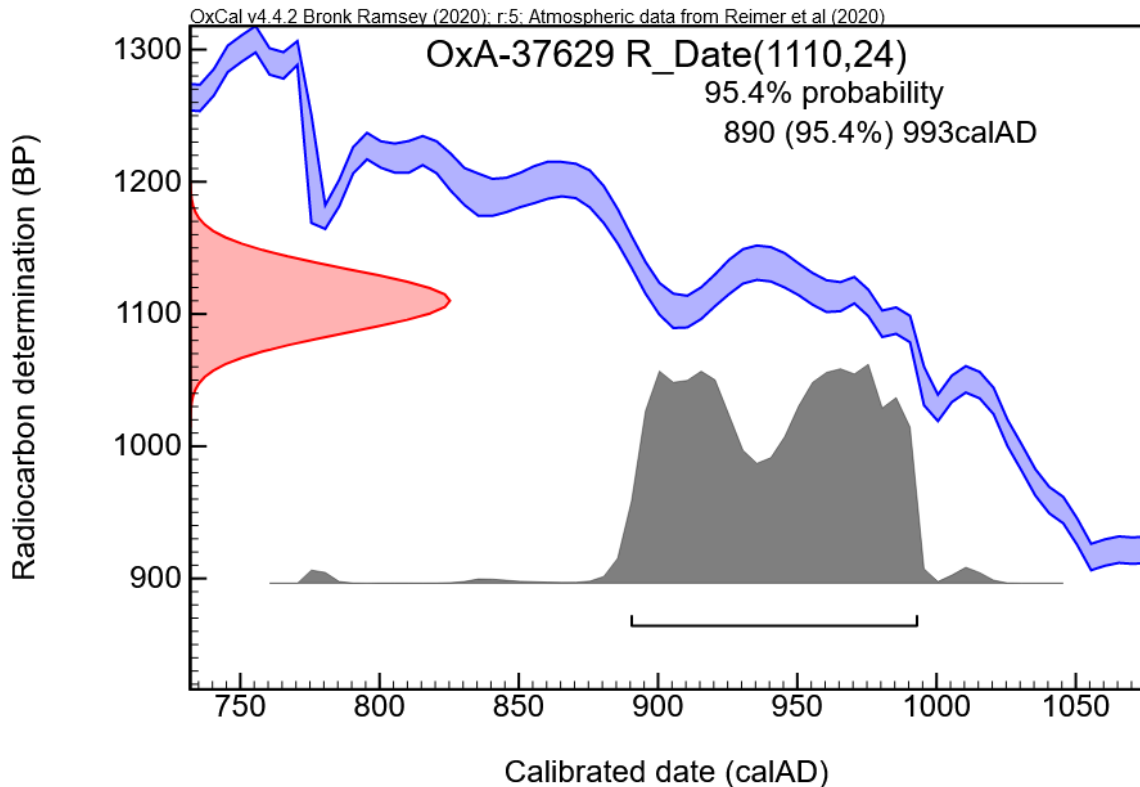
### *New radiocarbon dates*

The FeedSax project submitted a further five samples from Tipping Street for radiocarbon dating at the Oxford Radiocarbon Accelerator Unit. Two of them (205 and 203) are identical to the samples dated by Oxford Archaeology. The aim of obtaining extra dates from these samples was to refine, if possible, the chronological relationship between kilns 3408 and 3401, especially given the importance of the Tipping Street kiln sequence in establishing a (previously unexpected) pre-*burh* phase at Anglo-Saxon Stafford. Calibrations of the FeedSax radiocarbon results, using IntCal20 (Reimer *et al.* 2020) and conducted using OxCal 4.4.2 (Bronk Ramsey 2009), are given below.

feature	context	sample	grains	laboratory no.	age BP	calibrated date AD (confidence)
Kiln 3408	3203	205	3 x free-threshing wheat	OxA-37625	1082 ± 25	892–931 (30.8%), 941–1022 (64.6%)
	3205	204	3 x free-threshing wheat	OxA-37626	1159 ± 26	820–978 (84.8%)
Kiln 3401	3201	203	3 x free-threshing wheat	OxA-37627	1121 ± 26	881–994 (94.7%)
Kiln 4287	4319	406	3 x free-threshing wheat	OxA-37628	1109 ± 26	885–995 (95.4%)
Pit 366	381	11	3 x rye	OxA-37629	1110 ± 24	890–993 (95.4%)







### *Modelling the dates*

All of the radiocarbon dates detailed above have been included in a Bayesian statistical model in OxCal 4.4.2 (Bronk Ramsey 2009), based upon the chronological framework for Tipping Street outlined above. The model used here employs an outlier model for the charcoal samples, allowing for the possibility of an ‘old wood’ effect. Note that the available radiocarbon dates belong exclusively to Phase 2. The model is presented below in CQL2 code, along with the results in tabular and graphic form.

In this model, pre-*burh* activity (i.e. predating AD 913) appears to be less convincingly demonstrated than in the model produced by Oxford Archaeology. This is at least partly due to the additional radiocarbon date (OxA-37625) obtained from sample 205 in kiln 3408, which when calibrated gives an overlapping but later range than the original SUERC radiocarbon dates from the same sample. The older of the SUERC dates was obtained from charcoal (SUERC-38773), and may thus be subject to an old wood effect (the other, SUERC-38774, was obtained from charred grain).

Nonetheless, the probability distributions seem to suggest that Phase 2 activity in Tipping Street most likely commenced around the very end of the ninth century, and terminated around the middle of the tenth century. It is difficult to discern a more detailed chronology than this, but kiln 3408 predates kiln 3401 and is more likely to belong to the late ninth/early tenth century, whereas the other kilns are more likely to belong to the early/mid-tenth century. It is possible that the whole Phase 2 sequence represents a very narrow timespan at some point between the very late ninth and mid-tenth centuries. Sample 115 predates Phase 2 but is otherwise undated. However, its botanical composition is very similar to that of the Phase 2 samples and, on these grounds, there is no reason why sample 115 might not also be dated to the ninth century.



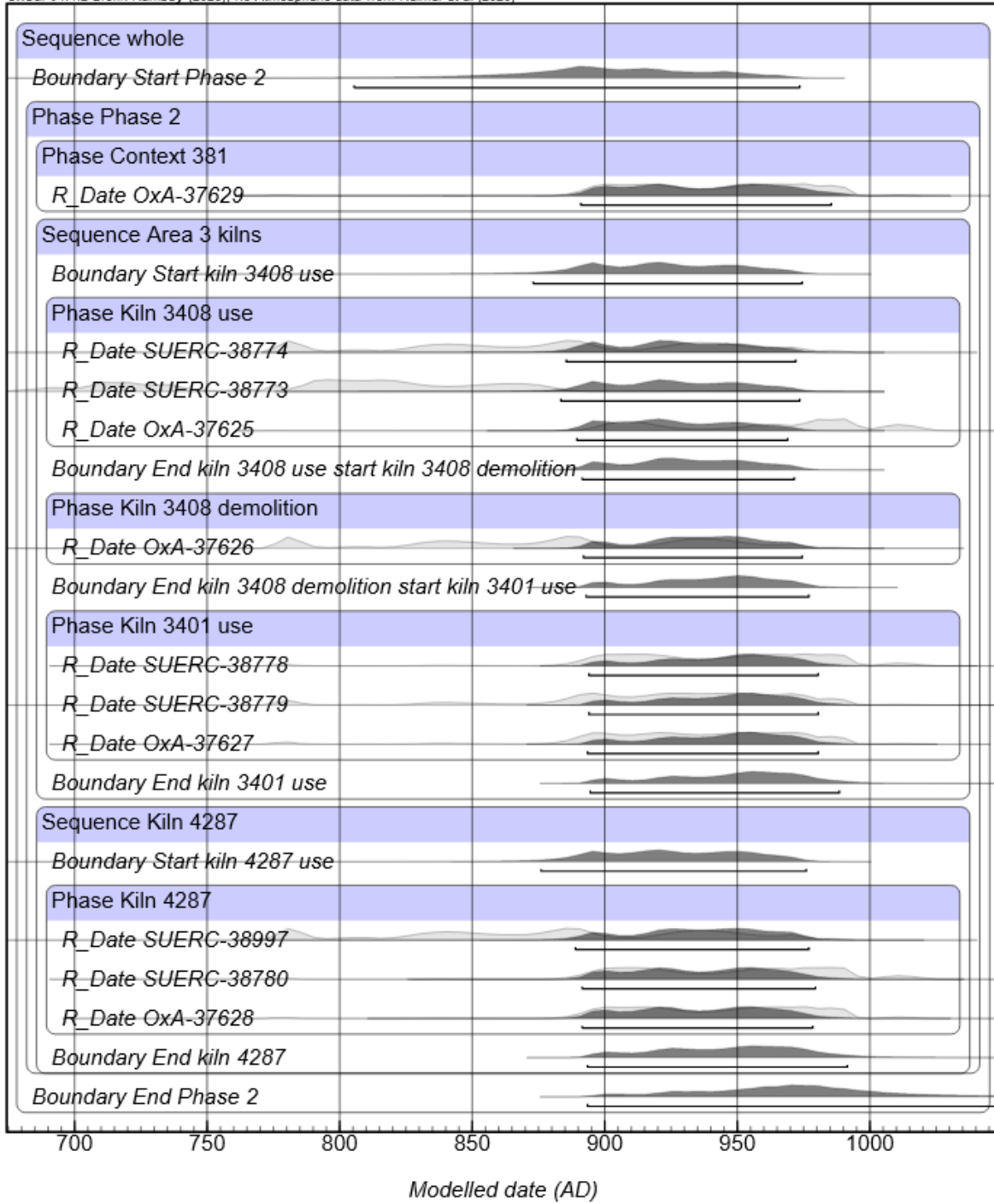
```
Plot()
{
  Outlier_Model("Charcoal",Exp(1,-10,0),U(0,3),"t");
  Sequence("whole")
  {
    Boundary("Start Phase 2");
    Phase("Phase 2")
    {
      Phase ("Context 381")
      {
        R_Date("OxA-37629", 1110, 24);
      };
      Sequence ("Area 3 kilns")
      {
        Boundary("Start kiln 3408 use");
        Phase ("Kiln 3408 use")
        {
          R_Date("SUERC-38774", 1160, 30);
          R_Date("SUERC-38773", 1230, 30)
          {
            Outlier("Charcoal",1);
          };
          R_Date("OxA-37625", 1082, 25);
        };
        Boundary("End kiln 3408 use start kiln 3408 demolition");
        Phase("Kiln 3408 demolition")
        {
          R_Date("OxA-37626", 1159, 26);
        };
        Boundary("End kiln 3408 demolition start kiln 3401 use");
        Phase("Kiln 3401 use")
        {
          R_Date("SUERC-38778", 1105, 30);
          R_Date("SUERC-38779", 1130, 30)
          {
            Outlier("Charcoal",1);
          };
          R_Date("OxA-37627", 1121, 26);
        };
        Boundary("End kiln 3401 use");
      };
      Sequence("Kiln 4287")
      {
        Boundary("Start kiln 4287 use");
        Phase("Kiln 4287")
        {
          R_Date("SUERC-38997", 1160, 30);
          R_Date("SUERC-38780", 1100, 30);
          R_Date("OxA-37628", 1109, 26);
        };
        Boundary("End kiln 4287");
      };
    };
    Boundary("End Phase 2");
  };
};
```



Name	Unmodelled (BC/AD)			Modelled (BC/AD)			Indices				Select	Page break		
							A <sub>model</sub> =79.8 A <sub>overall</sub> =84.6							
	from	to	%	from	to	%	A <sub>comb</sub>	A	L	P			C	All Visible
▼ Outlier_Model Charcoal				-173	3	95.4						99.8	<input checked="" type="checkbox"/> 32	<input type="checkbox"/>
Exp(1,-10,0)	-3.19	-0.05	95.4									99.5	<input checked="" type="checkbox"/> 2	<input type="checkbox"/>
U(0,3)	2.21177e-17	3	95.4	0.519	2.715	95.4	100					98.4	<input checked="" type="checkbox"/> 3	<input type="checkbox"/>
▼ Sequence whole													<input checked="" type="checkbox"/> 4	<input type="checkbox"/>
Boundary Start Phase 2				805	973	95.4						97.1	<input checked="" type="checkbox"/> 5	<input type="checkbox"/>
▼ Phase Phase 2													<input checked="" type="checkbox"/> 6	<input type="checkbox"/>
▼ Phase Context 381													<input checked="" type="checkbox"/> 7	<input type="checkbox"/>
R_Date OxA-37629	890	993	95.4	891	985	95.4	102					99.5	<input checked="" type="checkbox"/> 8	<input type="checkbox"/>
▼ Sequence Area 3 kilns													<input checked="" type="checkbox"/> 9	<input type="checkbox"/>
Boundary Start kiln 3408 use				873	974	95.4						98.6	<input checked="" type="checkbox"/> 10	<input type="checkbox"/>
▼ Phase Kiln 3408 use													<input checked="" type="checkbox"/> 11	<input type="checkbox"/>
R_Date SUERC-38774	773	978	95.4	885	972	95.4	93.5					99	<input checked="" type="checkbox"/> 12	<input type="checkbox"/>
R_Date SUERC-38773	681	885	95.4	883	973	95.4	88.4					99	<input checked="" type="checkbox"/> 13	<input type="checkbox"/>
R_Date OxA-37625	892	1022	95.4	889	969	95.4	66.4					99	<input checked="" type="checkbox"/> 14	<input type="checkbox"/>
Boundary End kiln 3408 use start kiln 3408 demolition				891	971	95.4						99.2	<input checked="" type="checkbox"/> 15	<input type="checkbox"/>
▼ Phase Kiln 3408 demolition													<input checked="" type="checkbox"/> 16	<input type="checkbox"/>
R_Date OxA-37626	772	978	95.4	892	974	95.4	89					99.2	<input checked="" type="checkbox"/> 17	<input type="checkbox"/>
Boundary End kiln 3408 demolition start kiln 3401 use				893	977	95.4						99.4	<input checked="" type="checkbox"/> 18	<input type="checkbox"/>
▼ Phase Kiln 3401 use													<input checked="" type="checkbox"/> 19	<input type="checkbox"/>
R_Date SUERC-38778	885	1016	95.4	894	980	95.4	103.8					99.4	<input checked="" type="checkbox"/> 20	<input type="checkbox"/>
R_Date SUERC-38779	774	994	95.4	894	980	95.4	105.6					99.4	<input checked="" type="checkbox"/> 21	<input type="checkbox"/>
R_Date OxA-37627	777	994	95.4	893	980	95.4	110.7					99.4	<input checked="" type="checkbox"/> 22	<input type="checkbox"/>
Boundary End kiln 3401 use				894	988	95.4						99.4	<input checked="" type="checkbox"/> 23	<input type="checkbox"/>
▼ Sequence Kiln 4287													<input checked="" type="checkbox"/> 24	<input type="checkbox"/>
Boundary Start kiln 4287 use				876	976	95.4						99.1	<input checked="" type="checkbox"/> 25	<input type="checkbox"/>
▼ Phase Kiln 4287													<input checked="" type="checkbox"/> 26	<input type="checkbox"/>
R_Date SUERC-38997	773	978	95.4	889	977	95.4	90.5					99.3	<input checked="" type="checkbox"/> 27	<input type="checkbox"/>
R_Date SUERC-38780	887	1017	95.4	891	979	95.4	100.2					99.2	<input checked="" type="checkbox"/> 28	<input type="checkbox"/>
R_Date OxA-37628	885	995	95.4	891	978	95.4	102.3					99.3	<input checked="" type="checkbox"/> 29	<input type="checkbox"/>
Boundary End kiln 4287				893	991	95.4						99.3	<input checked="" type="checkbox"/> 30	<input type="checkbox"/>
Boundary End Phase 2				893	1056	95.4						98.3	<input checked="" type="checkbox"/> 31	<input type="checkbox"/>



OxCal v4.4.2 Bronk Ramsey (2020); r:5 Atmospheric data from Reimer et al (2020)



## A chronology for the Stafford samples

On the basis of the evidence outlined above, and especially the new chronometric models, this report proposes a new phasing sequence for the three sites collectively. In the table below, the contexts/samples which have produced archaeobotanical remains of interest to the FeedSax project have been assigned to these phases. This scheme underlies the synthetic analysis published elsewhere (Hamerow *et al.* 2019).

In Phase 1, pre-dating the foundation of the *burh*, oven-/kiln-using activity starts in the Tipping Street area around the late ninth century, continuing until around the mid-tenth century, i.e. the early part of the *burh* period (Phase 2.1). Oven-/kiln-use begins around this time at the St Mary's Grove site (Phase 2.2). This phase of activity continues in the north-east part of the St Mary's Grove site until around the middle of the eleventh century (Phase 2.3): around, or immediately before, the time of the Norman Conquest.

Several features of the circum-Conquest or immediate post-Conquest period (Phase 3.1) have produced large quantities of charred plant remains, at both the St Mary's Grove (central area) and Bath Street sites. Into the twelfth and thirteenth centuries, activity continues in the north-east and south-west parts of the St Mary's Grove sites, plus at Tipping Street, with archaeobotanical material occurring mainly in pits (Phases 3.2 and 3.3).

Subsequently in the later medieval period, there was some renewed occupation at Tipping Street (Phase 4.1), while oven-/kiln-use resumed at St Mary's Grove in the south-west area (Phase 4.2); activity resumed in the north-east area in the post-medieval period (Phase 5).

SITE	FEATURE/CONTEXT	CONTEXT/SAMPLE	PHASING	CENTURIES
Tipping St	Kiln 3408 – 3203	205	1	late 9 <sup>th</sup> – early 10 <sup>th</sup>
Tipping St	Kiln 3408 – 3203	221	1	late 9 <sup>th</sup> – early 10 <sup>th</sup>
Tipping St	Group 3415 – 3205	204	1	late 9 <sup>th</sup> – early 10 <sup>th</sup>
Tipping St	Well 4330 – 4339	412	1	late 9 <sup>th</sup> – early 10 <sup>th</sup>
Tipping St	Pit 366 – 381	11	1	late 9 <sup>th</sup> – early 10 <sup>th</sup>
Tipping St	Buried soil – 2114	115	1	late 9 <sup>th</sup> – early 10 <sup>th</sup>
Tipping St	Well 4330 – 4344	411	1	late 9 <sup>th</sup> – early 10 <sup>th</sup>
Tipping St	Kiln 3401 – 3201	203	2.1	mid 10 <sup>th</sup>
Tipping St	Kiln 4287 – 4306	405	2.1	mid 10 <sup>th</sup>
Tipping St	Pit – 4319	406	2.1	mid 10 <sup>th</sup>
Tipping St	Kiln 4287 – 4305	404	2.1	mid 10 <sup>th</sup>
St Mary's Grove	oven 130	1682	2.2	mid – late 10 <sup>th</sup>
St Mary's Grove	oven 214	2243	2.2	mid – late 10 <sup>th</sup>
St Mary's Grove	oven 214	2195	2.2	mid – late 10 <sup>th</sup>
St Mary's Grove	oven 581	2242	2.2	mid – late 10 <sup>th</sup>
St Mary's Grove	pit 136	2140	2.2	mid – late 10 <sup>th</sup>
St Mary's Grove	pit 136	2136	2.2	mid – late 10 <sup>th</sup>
St Mary's Grove	pit 136	2134	2.2	mid – late 10 <sup>th</sup>
St Mary's Grove	oven 584	2247	2.3	late 10 <sup>th</sup> – mid 11 <sup>th</sup>
St Mary's Grove	well 608	2269	2.3	late 10 <sup>th</sup> – mid 11 <sup>th</sup>
St Mary's Grove	well 608	2267	2.3	late 10 <sup>th</sup> – mid 11 <sup>th</sup>
St Mary's Grove	oven 585	2228	2.3	late 10 <sup>th</sup> – mid 11 <sup>th</sup>
St Mary's Grove	oven 585	2223	2.3	late 10 <sup>th</sup> – mid 11 <sup>th</sup>
St Mary's Grove	oven 585	2222	2.3	late 10 <sup>th</sup> – mid 11 <sup>th</sup>
Bath St	pit 227	1066B	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
Bath St	pit 227	1069A	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
Bath St	pit 227	1069B	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
Bath St	pit 227	1071A	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
Bath St	pit 227	1071B	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
St Mary's Grove	quarry 426	2150	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
St Mary's Grove	quarry 435	2102 – 066/077	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
St Mary's Grove	quarry 435	2102 – 066/079	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
St Mary's Grove	quarry 435	2102 – 068/076	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
St Mary's Grove	quarry 435	2102 – 069/078	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
St Mary's Grove	quarry 435	2092	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
St Mary's Grove	SFB	1991	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
St Mary's Grove	SFB	1990	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
St Mary's Grove	SFB	1988	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
St Mary's Grove	SFB	1985	3.1	mid 11 <sup>th</sup> – mid 12 <sup>th</sup>
St Mary's Grove	pit 443	2185	3.2	early – mid 12 <sup>th</sup>
St Mary's Grove	pit 443	2184	3.2	early – mid 12 <sup>th</sup>
St Mary's Grove	pit 449	2178	3.2	early – mid 12 <sup>th</sup>
St Mary's Grove	pit 449	2172	3.2	early – mid 12 <sup>th</sup>
St Mary's Grove	pit 471	1929	3.3	early 13 <sup>th</sup>
St Mary's Grove	pit 478	1940	3.3	early 13 <sup>th</sup>
Tipping St	Ditch 2106 – 2104	118	4.1	13 <sup>th</sup> – 14 <sup>th</sup>
St Mary's Grove	ditch 298	1934	4.2	13 <sup>th</sup> – 16 <sup>th</sup>
St Mary's Grove	ditch 298	1839	4.2	13 <sup>th</sup> – 16 <sup>th</sup>
St Mary's Grove	kiln 323	1891	4.2	13 <sup>th</sup> – 16 <sup>th</sup>
St Mary's Grove	pit 303	1814	4.2	13 <sup>th</sup> – 16 <sup>th</sup>
St Mary's Grove	pit 303	1813	4.2	13 <sup>th</sup> – 16 <sup>th</sup>
St Mary's Grove	pit 320	1886	4.2	13 <sup>th</sup> – 16 <sup>th</sup>
St Mary's Grove	pit 320	1848	4.2	13 <sup>th</sup> – 16 <sup>th</sup>
St Mary's Grove	oven 188	2323	5	post-medieval
St Mary's Grove	oven 188	2322	5	post-medieval
St Mary's Grove	pit 176	1520	5	post-medieval
St Mary's Grove	pit 176	1519	5	post-medieval

## References

- Bronk Ramsey, C. (2009). 'Bayesian analysis of radiocarbon dates', *Radiocarbon* 51(1), pp.337–360.
- Carver, M. (2010). *The Birth of a Borough. An Archaeological Study of Anglo-Saxon Stafford* (Boydell Press: Woodbridge).
- Dodd, A., Goodwin, J., Griffiths, S., Norton, A., Poole, C. and Teague, S. (2013). Excavations at Tipping Street, Stafford, 2009–10: possible Iron Age roundhouses, three Stafford-type ware kilns and medieval and post-medieval urban remains. Unpublished report by Oxford Archaeology.
- Hamerow, H., Bogaard, A., Charles, M., Forster, E., Holmes, M., McKerracher, M., Neil, S., Bronk Ramsey, C., Stroud, E. and Thomas, R. (2020). 'An Integrated Bioarchaeological Approach to the Medieval "Agricultural Revolution": A Case Study from Stafford, England, c.AD 800–1200', *European Journal of Archaeology* 23(4), pp.585–609.
- McKerracher, M., Bogaard, A., Bronk Ramsey, C., Charles, M., Forster, E., Hamerow, H., Holmes, M., Hodgson, J., Neil, S., Roushannafas, T., Stroud, E. and Thomas, R. (in prep.). 'Feeding Anglo-Saxon England (FeedSax): the Haystack bioarchaeological database and digital archives', *Internet Archaeology*.
- Moffett, L. (1987). *The macro-botanical evidence from Late Saxon and early medieval Stafford*. Ancient Monuments Laboratory Report 169/87.
- Reimer, P., Baillie, M., Bard, E., Bayliss, A., Beck, J., Blackwell, P., ... Weyhenmeyer, C. (2009). 'IntCal09 and Marine09 Radiocarbon Age Calibration Curves, 0–50,000 Years cal BP', *Radiocarbon* 51(4), pp.1111–1150.
- Reimer, P., Austin, W., Bard, E., Bayliss, A., Blackwell, P., Bronk Ramsey, C., ... Talamo, S. (2020). 'The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0–55 cal kBP)', *Radiocarbon* 62(4), pp.725–757.