Radiocarbon dating archaeobotanical remains from kilns at Sedgeford

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Since 2013, the Sedgeford Historical and Archaeological Research Project has been excavating an Anglo-Saxon cereal-processing site at Sedgeford, Norfolk – now identified as a malting complex (Faulkner and Blakelock 2020). Ipswich Ware from the trench supported a date range of *c.* AD 725–850 for this unprecedented site, which has produced a large and rich assemblage of well-preserved charred plant remains. Perhaps the most significant archaeobotanical finds were those obtained from the malting kilns, at least three of which have been excavated, but it was initially unclear as to whether these kilns were in simultaneous use or rather represented successive structures.

The Feeding Anglo-Saxon England project (FeedSax) therefore collaborated with Hannah Caroe, a doctoral student analysing the malting complex assemblage at the University of Oxford, to establish a firmer chronology for the plant remains and, thus, the malting kilns (Caroe 2022). Charred grain samples from three contexts, one for each of kilns 1–3, 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 below and the figures at the end of this report. The grains – all identifiable as rye (*Secale cereale* L.) – were selected and photographed by the author at home; the photographs are included at the end of this report.

Results

kiln	context	grains	lab. no.	age BP	calibrated years AD (confidence)
1	17026	3 x rye	OxA-40485	1318±18	657–703 (51.8%), 740–774 (43.7%)
2	19061	3 x rye	OxA-40414	1269±18	672–777 (95.4%)
3	23372	3 x rye	OxA-40415	1225±18	772–880 (83.7%)

All of these radiocarbon date ranges are consistent with the original, Ipswich Ware-based chronology for the complex (*c.* AD 725–850). To investigate the chronological relationships between the kilns, however, it was necessary to deploy a Bayesian chronometric model using OxCal. The model is presented below in CQL code, along with results in tabular and graphical formats. Each kiln is assigned to its own phase within an overall 'malthouse' phase (i.e. with no sequence enforced upon the three kilns), and the Ipswich Ware chronology is used as an overall constraint, providing a *terminus post quem* and a *terminus ante quem* for the whole complex.

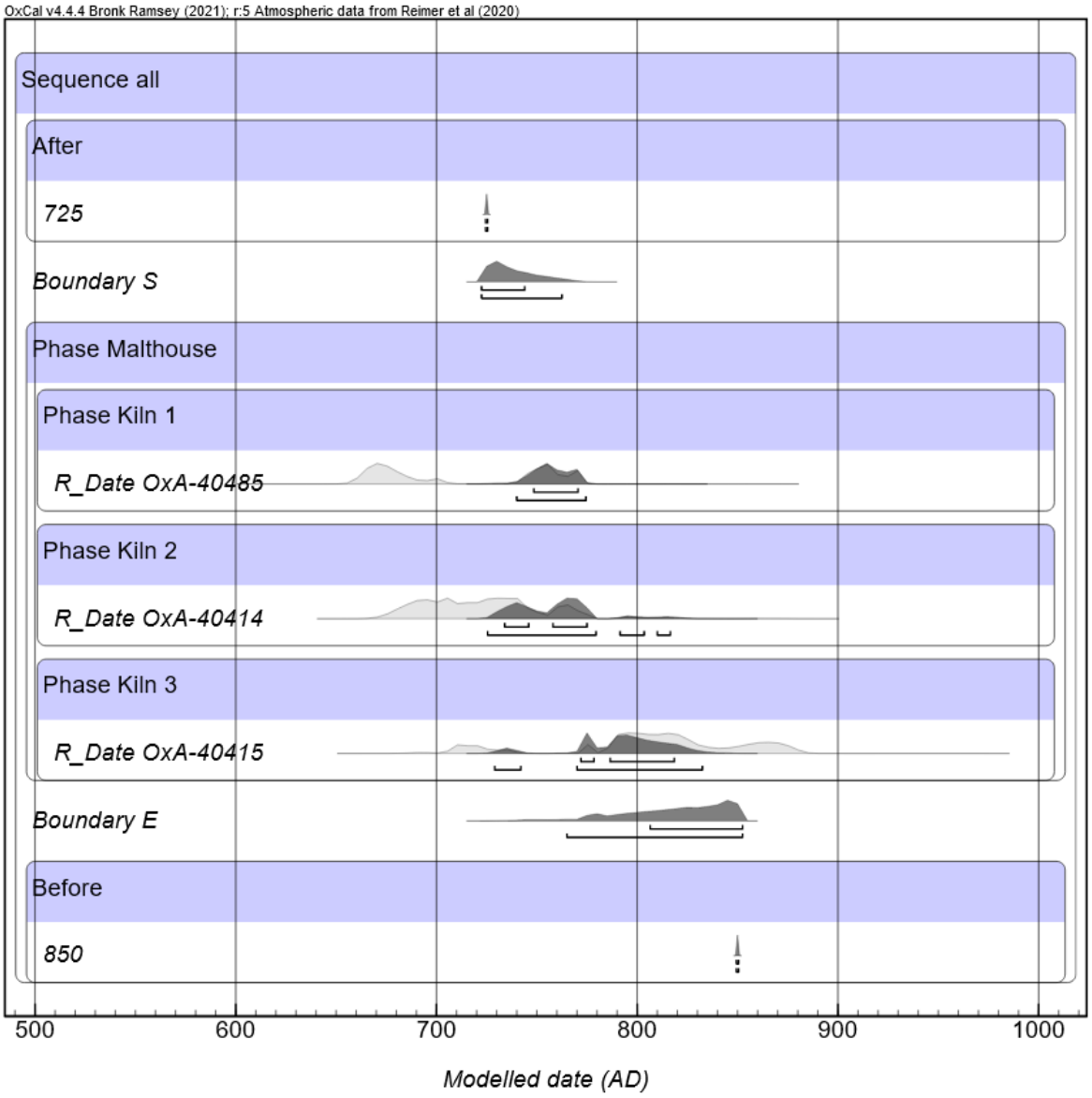
Chronometric model in CQL code

```
Plot()
 {
  Sequence("all")
  {
   After(Date(725));
   Boundary("S");
   Phase("Malthouse")
   {
    Phase("Kiln 1")
    {
     R_Date("OxA-40485", 1318, 18);
    };
    Phase("Kiln 2")
    {
     R_Date("OxA-40414", 1269, 18);
    };
    Phase("Kiln 3")
    {
     R_Date("OxA-40415", 1225, 18);
    };
   };
   Boundary("E");
   Before(Date(850));
  };
 };
```

Chronometric model: tabulated results

Name Show all Show structure		Unmodelled (BC/AD)						Modelled (BC/AD)						Indices A_{model}=84.7 $A_{overall}$=85.1					Select All Visible	Page break
		from	to	%	from	to	%	from	to	%	from	to	%	A_{comb}	A	L	P	C		
Sequence all																			2	
After		725	...	68.3	725	...	95.4												3	
725								724	725	68.3	724	725	95.4					100	4	
Boundary S								722	744	68.3	722	762	95.4					98.6	5	
Phase Malthouse																			6	
Phase Kiln 1																			7	
R_Date OxA-40485		662	772	68.3	657	774	95.4	748	770	68.3	740	774	95.4		95.2			97.5	8	
Phase Kiln 2																			9	
R_Date OxA-40414		685	743	68.3	672	777	95.4	734	775	68.3	725	816	95.4		75.2			98.5	10	
Phase Kiln 3																			11	
R_Date OxA-40415		786	873	68.3	706	880	95.4	772	818	68.3	729	832	95.4		105.8			97.8	12	
Boundary E								806	852	68.3	765	852	95.4					95.4	13	
Before		...	850.05	68.3	...	850.05	95.4												14	
850								849	850	68.3	849	850	95.4					100	15	

Chronometric model: graphical representation of results



The new radiocarbon dates, especially when modelled, thus suggest that kilns 1 and 2 may have been closely (though not necessarily *exactly*) contemporary within a mid-eighth-century phase, while kiln 3 most likely belonged to a subsequent phase between the later eighth and early ninth centuries. If it is assumed (in the usual way) that the charred plant remains represent the last firing of their respective kilns, then these suggested dates/phases relate specifically to the terminal use of the ovens, not their construction. The whole charred grain assemblage therefore probably spans no more than 85 years (*c*. AD 734–819), but the use-period of the kilns may potentially have been somewhat longer.

kiln	context	grains	lab no.	age BP	modelled years AD (confidence)
1	17026	3 x rye	OxA-40485	1318±18	748–770 (68.3%)
2	19061	3 x rye	OxA-40414	1269±18	734–775 (68.3%)
3	23372	3 x rye	OxA-40415	1225±18	772–819 (68.3%)

Acknowledgements

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References

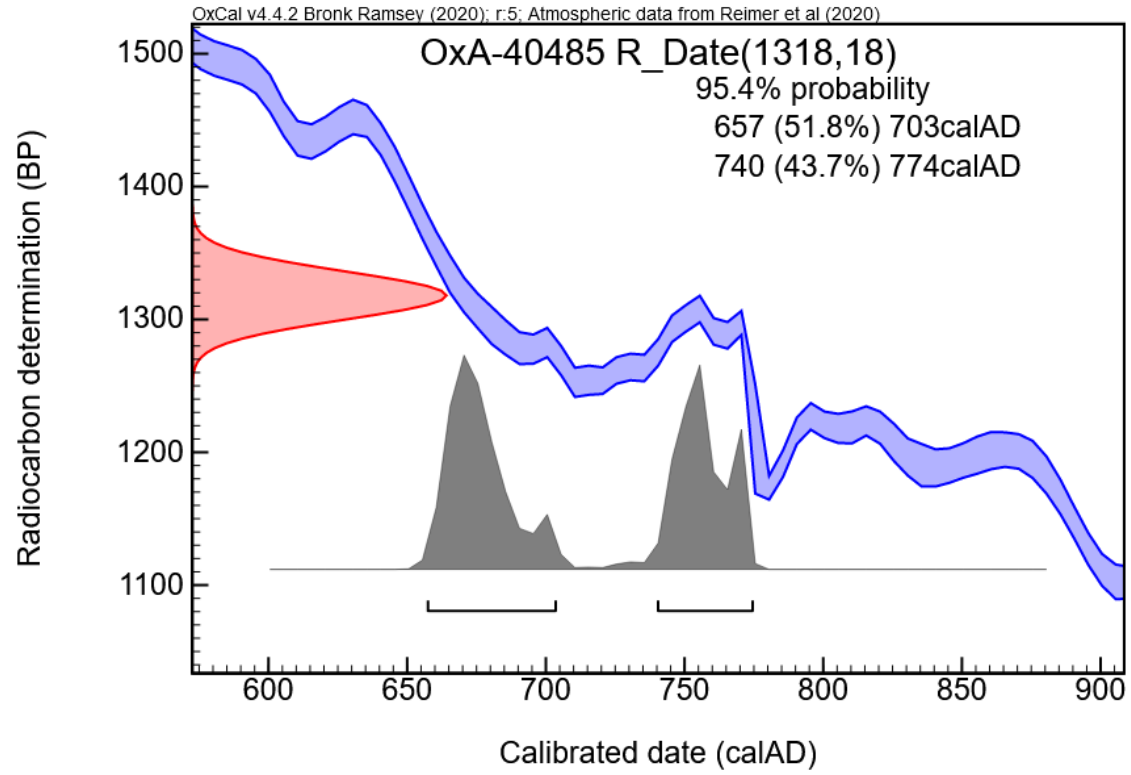
Bronk Ramsey, C. (2009). 'Bayesian analysis of radiocarbon dates', *Radiocarbon* 51(1), pp.337–360.

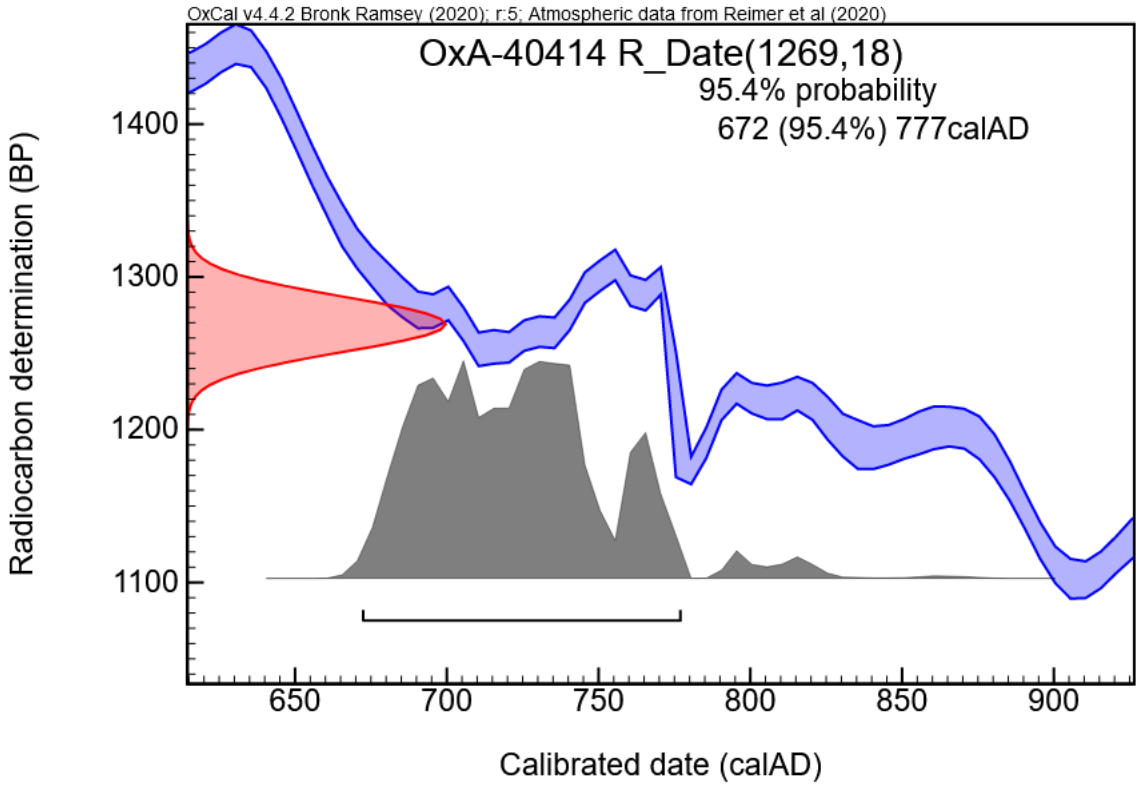
Caroe, H. (2022). 'Malting, brewing and beer in Anglo-Saxon England: Mid Saxon Sedgeford – a case study', in McKerracher, M. and Hamerow, H. (eds) *New Perspectives on the Medieval 'Agricultural Revolution': Crop, Stock and Furrow* (Liverpool: Liverpool University Press).

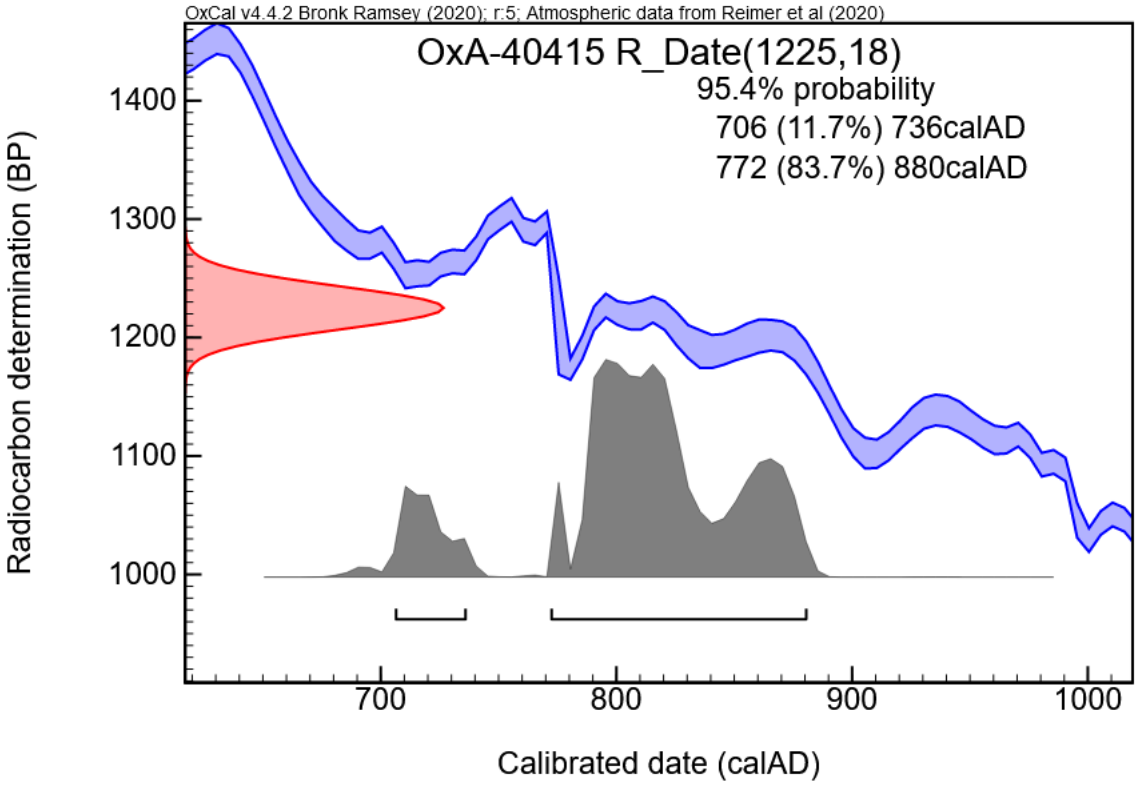
Faulkner, N. and Blakelock, E. (2020). 'The excavation of a Mid Anglo-Saxon malthouse at Sedgeford, Norfolk: an interim report', *Anglo-Saxon Studies in Archaeology and History* 22, pp.68–95.

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.

Calibration of radiocarbon determinations






OxCal v4.4.2 Bronk Ramsey (2020); r:5; Atmospheric data from Reimer et al (2020)
OxA-40415 R_Date(1225,18)
95.4% probability
706 (11.7%) 736calAD
772 (83.7%) 880calAD
Radiocarbon determination (BP)
1400
1300
1200
1100
1000
700
800
900
1000
Calibrated date (calAD)

Photographs of dated grains

Grains from 17026 (kiln 1)

Grains from 19061 (kiln 2)

Grains from 23372 (kiln 3)