The Archaeology of the A30 Bodmin to Indian Queens Road Scheme
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Radiocarbon analysis

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Introduction

Twenty-four radiocarbon dates were obtained from samples taken from sites along the A30 Bodmin to Indian Queens Road Improvement Scheme. Evidence from material-culture suggested that sites from a range of periods were represented along the route. Radiocarbon samples were selected in line with the research questions and after strategic consideration of the ability of scientific dating techniques to answer these objectives (Bayliss and Orton 1994). The nature of the stratigraphy, and the overall scarcity of palaeoecological material, meant that while a range of feature types and periods were sampled by the archaeological intervention, only a limited number of deposits were available for scientific dating.

A range of material types were selected by archaeologists from Oxford Archaeology. These included charred plant macrofossils, animal bone, and sub-samples of soil from pollen monoliths. Measurements were undertaken by accelerator mass spectrometry (AMS) at three laboratories. The bone sample was processed according the revised gelatinisation method outlined in by Bonk Ramsey *et al.* (2004) at Oxford Radiocarbon Accelerator Unit (ORAU). Single entity charcoal and charred plant remains were dated at Rafter (using standard acid/base/acid pre-treatment). Fractions of sediment were prepared and dated according to procedures outlined by Slota *et al.* (1987) and Xu *et al. (*2004) at Scottish Universities Environmental Research Council (SUERC).
The radiocarbon results are given in tables *1 and *2, key parameters mentioned in the text are given in table *3. They are quoted in accordance with the international standard known as the Trondheim convention (Stuiver and Kra 1986) and are conventional radiocarbon ages (Stuiver and Polach 1977).

Calibration and reporting

Calibrated radiocarbon determinations have been produced using OxCal v 4 (Bronk Ramsey 1995, 2001, 2007) with the calibration curve of Reimer *et al* (2004). The calibrated date ranges quoted in the text are at 95% confidence, and rounded out as appropriate to the precision of the date (Mook 1986). The mathematical models discussed here combine archaeological prior information and the radiocarbon determinations to produce posterior density estimates, according to convention these are quoted in italics. The calibrated ranges are all derived from the probability calibration method (Stuiver and Reimer 1986).

Bayesian statistical analysis

Bayesian analysis synthesises archaeological chronological information derived from stratigraphy, material-culture and scientific dating techniques. A number of limiting factors will effect the ability of a Bayesian model to address archaeological questions of interest (Baillie 1991; Waterbolk 1971). Assessment of the calibration curve for the archaeological sites comprising the A30 Bodmin to Indian Queens Road Improvement Scheme suggested that an extensive dating programme would be required to significantly refine the chronology at these half-lives (Bayliss and Ortner 1994). Moreover, though an extensive sampling programme was undertaken, the ecofact assemblages suitable for radiocarbon dating was limited, not least because of the acidic nature of the Cornish soils (precluding the preservation of bone in many deposits).

The stratigraphic information at many of the sites was limited primarily because of the rural nature of the excavation and the accompanying scarcity of archaeological relationships. The chronometric chronologies presented here are subsequently relatively unconstrained, with the exception of the palaeochannel, though address some aspects of statistical scatter (Steier and Rom 2000; Bronk Ramsey 1995). These models are interpretative expressions of current chronological understandings, which will be subject to revision as regional chronologies are revised. The resultant precision, is however, sufficient to confirm the chronology indicated by artefactual evidence on most of the sites, though in the case of one site (Lower Trenoweth roundhouse, Roche), the chronometric dating suggests either a possible alternative interpretation of the archaeological features, or the presence of intrusive material within the context, in spite of careful selection procedures.

This modelling uses the program OxCal v 4 (Bronk Ramsey 2007) incorporating a form of Markov Chain Monte Carlo sampling, exclusively using the Metropolis-Hastings algorithm (see, for example Gilks *et al.* 1996)

Results
(See tables *1-*3)

Lower Trenoweth roundhouse, Roche
Two samples were selected for dating from the roundhouse, one from the inner penannular ditch (NZA-29325), and one from the outer ditch (NZA-29326). The determinations from this site are not statistically consistent and therefore represent material of different ages (T'=154.8, v=1, T' (5%)=3.8; Ward and Wilson 1978). The morphology of this site, comprising a distinctive hexagonal arrangement of interior postholes, and entrance to the south-east and roughly circular ring gully, and the close similarity with the form with the nearby Belowda roundhouse (800m to the west, see below), initially suggested an Iron Age date for activity, however these determinations both fall into the historic period. NZA-29325 dates to the early modern historic period, *1470-1640 cal AD (95.4% probable)*. NZA-29326 dates to the late Saxon or early Saxo-Norman, *890-1050 (81.3% probable)* or *1080-1160 (14.0% probable).* If these samples were statistically consistent and therefore potentially represented the same phase of activity, it would be more satistisfactory to argue that the whole structure was post-Iron Age. Morphologically the structure is regarded as prehistoric, though the material-culture evidence for this site was very limited and not chronologically diagnostic. It is equivocal whether the morphological assumptions are incorrect, or the chronometric samples intrusive.

Belowda roundhouse, Roche
Two samples were selected from a ditch fill from the Belowda roundhouse. The samples came from the same intervention through the ditchfill (group number 4147). The determinations from the ditch (NZA-29341 and NZA-25410) show good agreement when modeled as a sequence (A_{model}=111.1%, $A_{overall}$=109.3%) and suggest that the charred plant remains which were dated died in the first millennium cal BC and most probably in the second half of the first millenium between *680-90 cal BC (Boundary Start Site B Ditch; 87.9%)*. The agreement of the determinations within the stratified sequence (even though they are relatively unconstrained) suggests more robust evidence for activity at the site at this point in time than a single date would. This is in broad agreement with the initial assumptions based on the morphology of the site. In this case, artefactual evidence, including a near complete pottery vessel found within the in-filled outer ring-ditch suggested a date between c. 100BC and AD200 for the in-filling of the ditch.

Belowda pit and hearth group, Roche
Two dates were produced from evidence for settlement activity concentrated on at hearth at Roche. The determinations originated from a pit (NZA-29359) and a ditch terminus (NZA-25411). These determinations are not however statistically consistent (T'=262.0; v=1; T'(5%)=3.8; Ward and Wilson 1978), meaning that they cannot be the same age. The chronology from this site is relatively poorly understood; NZA-25411 represents an early to middle Bronze Age date (*1610-1420 cal BC; 95.4% probability)* while NZA-29359 produced

a late Neolithic/early Bronze Age date (*2470-2290 cal BC; 95.4% probability).* Bronze Age pottery and a saddle quern were recovered from this site.

Lane End pit circles, Roche

The morphology of the pit circles suggested a Bronze Age date. The two pit circles did not have any extant stratigraphic relationships when excavated. One of the pits in the eastern circle was cut by a pit which was part of a linear pit alignment. The linear pit alignment was interpreted as post-medieval borrow or extraction pits. Two samples were selected from one of the pits in the western circular pit alignment ref to context eg lower fill context 4038 (NZA-29360 and NZA-26253). These determinations are statistically consistent (T'=2.9; v=1; T' (5%)=3.8; Ward and Wilson 1978) indicating that at this precision they could be the same age.

Two samples forming a sequence were dated from the eastern pit circle (NZA-26254 and NZA-29342). NZA-29342 produced a posterior density estimate of *1660-1890 cal AD (78.4% probable)* or *1910-1950 cal AD (17.0% probable)*. This sample originated from the lower fill in the sequence, and must be regarded as intrusive modern material. No evidence for disturbance to the deposit was noted during excavation, though palaeoenvironmental assessment indicates modern root intrusion that might be the source of the contamination (Oxford Archaeology 2007:104). The dating evidence for the pit circles available here places them in the late Early Bronze Age.

The samples dated here from the west pit circle and the east pit circle do not demonstrate clear phasing. The estimate from the eastern circle *1690-1520 cal BC (NZA-26254; 95.4% probable)* overlaps with the latest posterior density estimate from the dated context in the western circle (*Last west; 1750-1640 cal BC; 95.4%)*

The linear pit alignment stratigraphically post-dates the eastern pit circle. NZA-26255 produced a medieval determination *1290-1430 cal AD (95.4% probable).*

Royalton hengiform, St Columb Major

Three short-lived ecofacts were available from the Royalton hengiform monument. Unfortunately all the samples originated from the exterior pit alignment, the interior pit or post circle therefore is not dated by chronometric means. This site was truncated by a later trackway that cut one of the pits from which a sample was dated. OxA-16125 was an *Ovis/Capra* (sheep/goat) tooth. This sample produced a much later date than the other two from the pits; *780-790 cal AD (1.8% probable)* or *800-980 cal AD (93.6% probable)*. This Saxon period date seems to have been incorporated in the pit as a result of later disturbance associated with the trackway. The two other determinations (NZA-29340 and NZA-29302) are statistically consistent (T'=0.3; v=1; T'(5%)=3.8; Ward and Wilson 1978), which further supports the interpretation of the date of OxA-16125 as intrusive. The *Corylus avellana* charcoal dated by NZA-29340 died between *2890-2620 cal BC (95.4% probable)* while the Maloideae charcoal dated by NZA-29302 died between *2910-2830 cal BC (28.7% probable)* or *2820-2660 cal BC (66.7% probable)*. The statistical agreement between the two undisturbed pit deposits indicates that activity occurred at the site during the later Neolithic.

The palaeochannel

A series of 5 dates were produced on the humic acid fraction of soil from deposits sampled by monoliths through a palaeochannel. The posterior density estimates show good agreement (A_{model}=89.1, $A_{overall}$=90.1, A'c=60) when modelled as a sequence. It seems most likely that the palaeochannel began infilling from the Middle Bronze Age (SUERC-10873*; 1490-1480 cal BC (0.7%)* or *1460-1290 cal BC (94.7%)).* Though it is possible that the channel began infilling from the Neolithic onwards (*Start infilling*; *5040-4980 cal BC (0.3% probable)* or *3850-1290 cal BC (95.1% probable)).*

The isolated pit 10010 at Innis Downs

A large quantity of charcoal was recovered from an isolated pit. The feature was the only potential pre-historic archaeology in the vicinity. A single entity of *Quercus* (oak) sp. heartwood was selected for dating. The quantity of charcoal in the pit suggests that the date represents a *terminus post quem* for the pit rather than individual intrusive items. However, because the dated material was heartwood, there is significant potential for an old wood effect and an offset between the point of death of the oak tree(s) and the deposition of the material in the pit.

Estimation of the probable age at death of this sample is complex given the absence of wild oak woodland in Britain. All potential analogues show significant management in the last three centuries and the age profile of stands can sometimes be correlated directly to historic events (Thompson *et al*. 2001). Because of the poor understanding of wild oak woodland ecology the ranges presented in table *2 are examples of the effect of different ages at deaths on the range of the sample. These offsets all produce a Mesolithic date range, which seems most likely to represent a *terminus post quem* for the pit.

Ditch 3355 near Belowda

Two determinations were available from a sequence through deposits infilling a ditch near Belowda (NZA-29358 and NZA-29324). These showed good agreement and produced posterior density estimates indicating activity from the late Roman or immediately post-Roman, to late Saxon.

Table *1: Radiocarbon dates from A30 Bodmin to Indian Queens Road Improvement Scheme

Laboratory number	Sample ID	Material	Radiocarbon Age (BP)	$\delta^{13}C$ (‰)	Calibrated Date (95% confidence)	*Posterior Density estimate (95% probability)*
NZA-29326	<3448> (3450)	Charcoal- *Ulex/Cytisus*	1027±40	-26.0	890-1050 cal AD (85.9%) or 1080-1160 cal AD (9.6%)	*890-1050 cal AD (81.3%)* or *1080-1160 cal AD (14.0%)*
NZA-29325	<3469> (3467)	Charred grain - *Avena/Bromus* sp	322±40	-24.3	1470-1450 cal AD	*1470-1640 cal AD*
NZA-25410	<4014> (4143)	Charcoal - Corylus avellana, 1 frag.	2131±35	-25.4	360-290 cal BC (14.6%) or 230-50 cal BC (80.8%)	*340-310 cal BC (2.6%) or 210-40 cal BC (92.8%)*
NZA-29341	<4015> (4144)	Charred grain, *Triticum aestivum/durum*	2131±40	-22.4	360-290 cal BC (16.9%) or 240-40 cal BC (78.5%)	*360-280 cal BC (16.7%)* or *240-60 cal BC (77.8%)*
NZA-29359	<4016> (4137)	Charcoal. *Corylus avellana*	3893±20	-25.6	2470-2300 cal BC	*2470-2290 cal BC*
NZA-25411	<4126> (4448)	Charcoal. Maloideae	3226±35	-25.6	1610-1430 cal BC	*1610-1420 cal BC*
NZA-29358	<3018> (3360)	Charcoal. *Salix/Populus* roundwood	1301±15	-25.0	660-720 cal AD (64.3%) 740-770 cal AD (31.1%)	*660-720 cal AD (72.9%)* or *740-770 cal AD (22.5%)*
NZA-29324	<3019> (3361)	Charred grain- *Avena/Bromus*	1640±40	-23.9	350-560 cal AD	*380-570 cal AD*
NZA-29356	<6000> (6014)	Charred tuber	326±15	-27.8	1490-1640 cal AD	-
NZA-29360	<4038> (4247)	Charcoal. *Corylus* sp.	3403±15	-27.6	1750-1640 cal BC	*1750-1640 cal BC*
NZA-26253	<4038> (4247)	Charcoal. *Corylus avellana*	3460±30	-28.0	1890-1690 cal BC	*1880-1690 cal BC*
NZA-29342	<4071> (4285)	Charcoal - twig frag	162±40	-28.2	1670-1890 cal AD (78.1%) or 1910-1950 cal AD (17.3%)	*1660-1890 cal AD (78.3%) 1910-1950 cal AD (17.1%)*
NZA-26255	<4074> (4330)	Charcoal. Twigs nfi.	580±40	-26.6	1290-1430 cal AD	*1290-1430 cal AD*
NZA-26254	<4070> (4284)	Charcoal. *Corylus avellana*	3328±30	-26.9	1680-1520 cal BC	*1690-1520 cal BC*
NZA-29340	<1050> (1131)	Charcoal - *Corylus avellana*,	4175±45	-26.5	2890-2620 cal BC	*2890-2620 cal BC*
NZA-29302	<1022> (1173)	Charcoal - cf. Maloideae,	4208±40	-26.3	2904-2840 cal BC (30.7%) or 2820-2660 cal BC (64.7%)	*2910-2830 cal BC (28.7%)* or *2820-2660 cal BC (66.7%).*
OxA-16125	<1042> (1178)	Tooth. *Ovis/Capra*	1142±25	-22.0	780-790 cal AD (1.8%) or 810-980 cal AD (93.6%)	*780-790 cal AD (1.8%)* or *800-980 cal AD (93.6%).*
SUERC-10872	(25003)	Sediment	250±35	-29.1	1520-1600 cal AD (20.2%) or 1610-1690 cal AD (47.5%) or 1730-1810 cal AD (21.8%), or 1930-1950 cal AD (5.8%)	*1640-1680 cal AD (12.7%)* or *1730-1810 cal AD (63.5%)* or *1930-1950 cal AD (19.2%)*
SUERC-10873	(25004)	Sediment	3115±35	-29.0	1500-1290 cal BC (95.4%)	*1490-1480 cal BC (0.7%)* or*1460-1290 cal BC (94.7%)*

SUERC-16074	(25004)	Organic soil - humic fraction	995±35	-29.1	980-1160 cal AD	*980-1160 cal AD*
SUERC-16075	(25004)	Organic soil - humic fraction	200±35	-29.3	1640-1700 cal AD (25.9%) or 1720-1820 cal AD (50.8%) or 1850-1870 cal AD (0.5%) or 1910-1950 cal AD (18.2%)	*1630-1810 cal AD (93.5%)* or*1930-1950 cal AD(1.9%)*
SUERC-16076	(25004)	Organic soil - humic fraction	2220±35	-29.0	390-200 cal BC	*390-200 cal BC*
NZA-29361	<5002> (5119)	Charred stems nfi	190±15	-26.8	1660-1690 cal AD (21.6%) or 1730-1810 cal AD (50.8%) or 1930-1960 cal AD (23.0%)	-
NZA-29357	<10000> (10011)	Charcoal. *Quercus* sp. heartwood	7687±20	-25.4	See table *2	N/a

Table *2: Examples of the 'old wood effect' on the determination from isolated pit 10010

Age at death	Calibrated date range (95.4%) cal BC
1000	*5590-5460*
500	*6090-5960*
200	*6390-6260*
100	*6490-6360*
50	*6540-6410*

Table *3

Site	Parameter quoted in text	Posterior density estimate (95.4% unless otherwise quoted)
Palaeochannel	*Start infilling First*	*5040-4980 cal BC (0.3%)* or *3850-1290 cal BC (95.1%)*
Belowda roundhouse, Roche	*Boundary Start Site B Ditch*	*680-90 cal BC (87.9%)*
Lane End pit circles, Roche	*Last west*	*1750-1640 cal BC*

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