Appendix 7.6

Killerby Prospect Geoarchaeological Evaluation

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Introduction

7.6.1 This report presents the results of the Phase 2 evaluation of landform settings and potential archaeological associations in the Killerby Prospect Development Area in the valley of the River Swale near Catterick, North Yorkshire. The Phase 1 desktop evaluation was based on a desktop analysis of (i) bedrock and superficial geology maps published by the BGS and accompanying memoirs, (ii) Ordnance Survey map coverages at 1:10,000 and 1:25,000, (iii) Ordnance Survey historic maps (1st Edition County Series), (iv) colour aerial photograph coverage available from various on-line sources, (v) unpublished geomorphological mapping by Mitchell (pers. comm.) and (vi) published mineral assessment reports and an investigation of Holocene river valley floor development at Brompton-on-Swale, 6km upstream of the Killerby prospect area (Taylor et al. 2000). The Phase 1 evaluation derived a classification of landform elements and their potential archaeological associations (following Passmore et al. 2006) using BGS superficial geology interpretations, with the additional step of delimiting the margins of well-defined Holocene palaeochannels evident as cropmarks on aerial photographs. Interpretations have also been informed by Mitchell's (unpublished) geomorphological mapping, although no attempt was made to adjust unit margins delimited by the BGS coverage. This Phase 2 assessment builds on the original evaluation by synthesising the results of a programme of sediment coring, assessment of pollen preservation and radiocarbon dating of selected sedimentary units. The coring transect intended to be undertaken across Field 7 in the proposed Phase 3 Development Area was not undertaken as a more comprehensive borehole survey was undertaken for geotechnical purposes across this area and this data was made available to the author as part of this study.

Methdology

7.6.2 A total of 14 sediment cores were extracted from locations within the designated extraction areas that were considered to have a high potential for preserving sequences of fine-grained and organic-rich sediment; these included palaeochannels, low-lying enclosed basins and kettle-hole depressions. All cores were taken using a hand-operated gouge auger and logged on-site; peaty and organic-rich sedimentary units were sampled in the field for assessment of pollen preservation and radiocarbon dating. Seven sediment cores were selected for pollen and radiocarbon analyses; these yielded 12 samples for pollen analyses and 8 samples for radiocarbon assay. Full details of the methodology and results of pollen and radiocarbon analyses are presented in the accompanying report below by Hopla and Gearey (2009) and SUERC (2009), respectively. The following sections describe (i) the results of the Phase 2 analysis in the context of the landform element classification developed in Phase 1 and (ii) an overview of the results with recommendations for further geoarchaeological investigations at the site.

7.6.3 Figure 7.6.1 shows the location of sediment cores KB1-14 relative to landform element classifications and the Development Area respectively. Table 7.6.1

summarises the sedimentary sequences, radiocarbon dating and pollen assemblages (where available) for each sediment core.

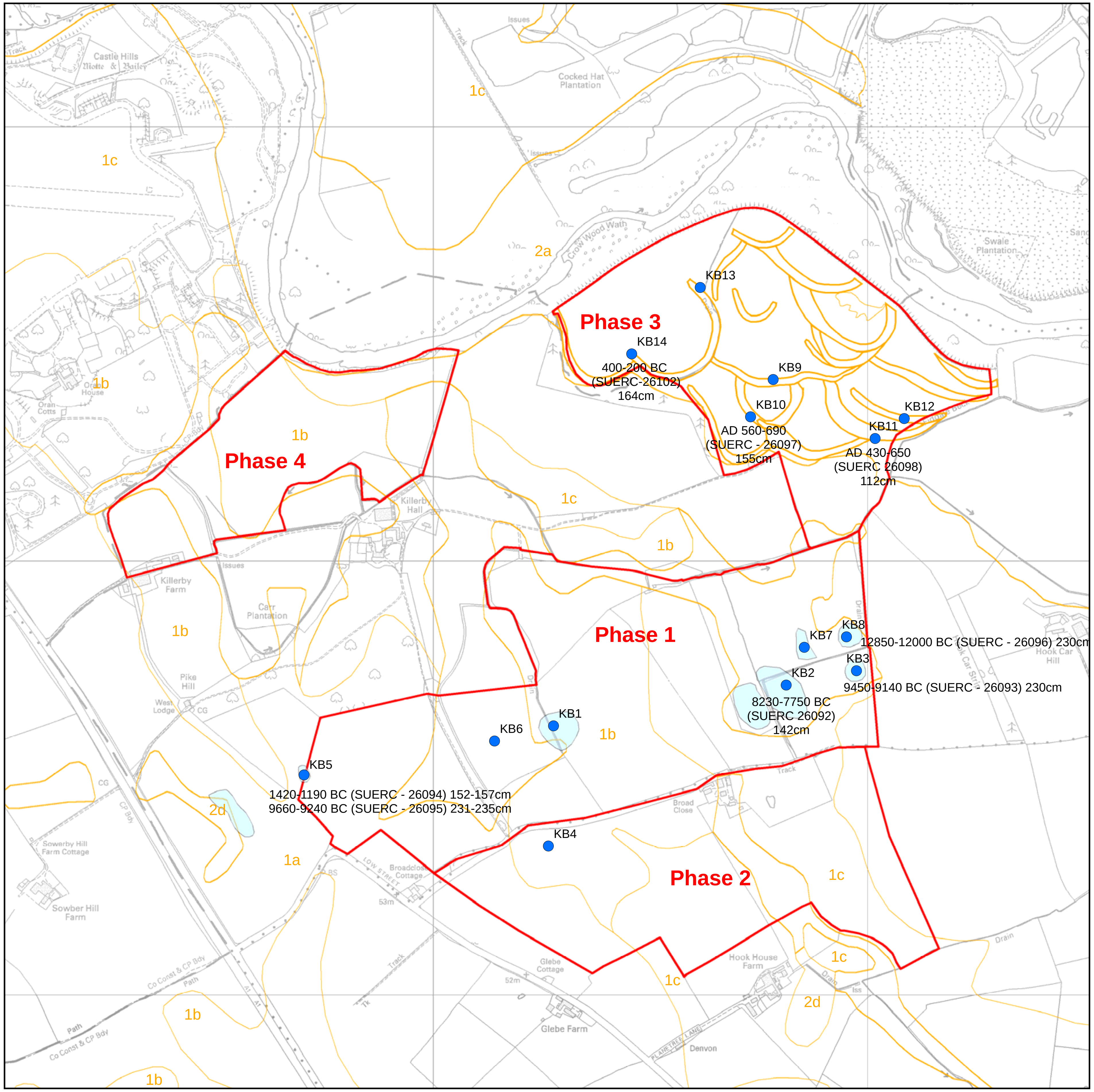

Fig. 7.6.1
Location of cores, associated radiocarbon dates and landforms

Project name: Killerby
Project Code: KILL09
Drawing reference:
Date: 11/09
Drawn by: JS
Scale: 1: 10000 at A3

Late Upper Palaeolithic
SUERC-26096

Mesolithic
SUERC-26092
SUERC-26093
SUERC-26095

Bronze Age
SUERC-26094

Iron Age
SUERC-26102

Early Medieval
SUERC-26097
SUERC-26098

Peat/Wetlands

Landform Units

Landform Units

1a Till
1b Glaciofluvial Deposits
1c River Terrace
1d Glaciofluvial Sheet
2a Alluvium
2b Palaeochannels
2c Lacustrine Deposits
2d Peat

N W E S

0 125 250 500 m

Illustration by ARS Ltd

Category 1a: Till (Devensian), Sediment core KB5

7.6.4 On the extreme western margin of the Phase 1 and 2 extraction area a small kettle-hole depression set into Category 1a till deposits was investigated by sediment core KB5 (Fig 7.6.1). This revealed a fine-grained infill sequence some 278 cm in depth that overlay gravelly clays and sandy gravels (Table 7.6.1). The upper part of the infill sequence between 0-152 cm comprised inorganic sands, silts and clays with some fine gravel inclusions. Between 152-270 cm the sediments exhibited varying amounts of organic content including, between 152-157 and 231-235 cm, peaty silt and silty humified peat. The upper peaty silt unit has been 14C dated to c.1420-1130 cal BC (SUERC-26094; Table 7.6.1) in the Middle Bronze Age and has a pollen assemblage that is characteristic of mixed woodland (especially alder, but also including hazel, pine and oak) with areas of open grassland and pasture. Silty peat deeper down the profile between 231-252 cm has been dated in its upper levels by bulk 14C to c.9660-9240 cal BC (SUERC-26095; Table 7.6.1) in the Early Mesolithic and contains pollen characteristic of a sedge fen with some birch woodland scrub vegetation. Radiocarbon dates from these respective units are broadly consistent with their associated pollen assemblages and imply a depositional timespan of some 8000 years between c.152-270 cm, although the possibility of non-depositional hiatuses in the sequence cannot be discounted and will require further investigation. Localities delimited as till in the Killerby area are likely to have experienced relatively little Holocene geomorphological activity with the exception of localised fluvial erosion and alluviation in lower elevation parts of the landscape, and possibly localised colluviation on slope facets. Sediment core KB5 demonstrates that localised kettle-hole depressions developed in the surface of this landform element are liable to have acted as long-term depositional environments that have preserved sedimentary sequences extending over part or all of the Holocene; these include waterlogged and organic-rich deposits that not only have high potential for preserving a wide variety of archaeological materials in-situ, but also a record of the localised activities of former communities as expressed in the palaeoenvironmental record of vegetation changes.

Category 1b: Glaciofluvial deposits (Devensian),sediment cores KB1 and KB4

7.6.5 Two sediment cores were located in areas mapped as Category 1b glaciofluvial sand and gravel deposits. Core KB4 was located in a sub-circular depression in the south-west part of the Phase 1 and 2 extraction area (Figure 7.6.1) and was intended to establish whether the depression was a kettle-hole or a bomb crater associated with the airfield to the north; this core was terminated on sand and gravel within 30 cm of the surface and this, in combination with extensive gravelly topsoil evident throughout the vicinity, is taken as confirmation of the bomb crater hypothesis. Sediment core KB1 was located some 250 m north of KB4 in a broad, low-elevation depression that merges with Category 2a alluvium to the west (Figure 7.6.1). This core yielded 200 cm of fine-grained inorganic sand, silt and clay that below 120 cm became clean, well-laminated and increasingly sandy (Table 7.6.1).

The core was terminated at 200 cm on the assumption that the laminated sediment was of Lateglacial age.

Category 2a: Holocene alluvium and Category 2b: Holocene palaeochannels

7.6.6 Holocene alluvium is extensively developed at lower elevations (c.35-40m OD) flanking the present River Swale and forms all bar the southerly extent of the Phase 3 extraction area. These deposits feature a complex suite of cross-cutting meandering palaeochannels (evident as cropmarks) that are representative of shifting Holocene channel courses associated with lateral migration and incision of the River Swale in this part of the valley floor. For the current evaluation only the most clearly defined features have been delimited on Figure 7.6.1 and it is anticipated that further channel forms, as well as modifications of the current mapping, will follow in any subsequent mitigation work. Ordnance Survey maps (1st edition, County Series) indicate that the present course of the River Swale has not changed significantly since c. AD 1857 and hence palaeochannels evident on the Phase 3 alluvial surface pre-date the mid-nineteenth century. However, the course of the river has changed since the medieval period as the parish boundary still follows an earlier course of the river that arcs around the base of the terrace scarp in the northern part of the proposed development area.

7.6.7 A total of 6 sediment cores were extracted from palaeochannels in the Phase 3 extraction area, all being located in well-defined topographic depressions that are also evident as cropmarks on vertical aerial images (Figure 7.6.1). Cores KB13 and KB14 were taken from the downstream and upstream limits, respectively, of a large palaeomeander loop in the north-west part of the Phase 3 extraction area (Figure 7.6.1) and found fine-grained channel fill deposits to reach a maximum thickness of 2m above former channel bed gravels (KB14, Table 7.6.1). Channel fill sediments in KB13 comprised fining-upward sands and silts with little organic content. The deeper channel fill sequence in KB14, however, featured humified peat and organic-rich silty sediments between 138-175 cm that have been 14C dated at 164 cm to c.400-200 cal BC (SUERC-26102; Table 7.6.1) and suggests that this palaeochannel was abandoned sometime during the mid-Iron Age. Pollen analysis of sediments between 160-170 cm indicate that the mid-Iron Age landscape in the vicinity of the palaeochannel featured a mixed woodland assemblage (dominated by hazel and alder) with areas of open grassland and heathland.

7.6.8 To the southeast of the KB13/14 palaeochannel sediment cores KB9-12 sampled four discrete palaeochannel fragments in the central and eastern parts of the Phase 3 extraction area (Figure 7.6.1). Channel fills sampled by cores KB9 and KB12 were found to reach a thickness of 100 cm and 60 cm, respectively, above gravelly bed material and comprised fining-upward inorganic sands and silts (Table 7.6.1). Sediment core KB10 was extracted from a sinuous palaeomeander bend that appears to have been truncated by the younger KB9 channel immediately to the north (Figure 7.6.1). Fine-grained channel fill sediments in KB10 attained a thickness of 190 cm above channel bed gravels and included a bed of silty macrofossil-rich peat between 150-175 cm (Table 7.6.1). This unit has been 14C dated at 155 cm to c. cal AD 560-770 (SUERC-26097; Table 7.6.1) placing it the early Anglo-Saxon period and between 155-165 cm has a pollen assemblage characteristic of a sedge-alder fen carr. Sediment core KB11 sampled a palaeochannel fragment on the eastern margin of the Phase 3 extraction area and here the fine-grained channel fill sequence reached a depth of 150 cm. The lower part of the sequence between 100-150 cm was found to comprise humified peaty silt that has been 14C dated at 112 cm to c. cal AD 430-650, also in the Early Medieval period, and has a pollen assemblage between 110-120 cm that is characteristic of largely treeless open grassland with areas of pasture and arable cultivation (SUERC-26098; Table 7.6.1). Radiocarbon dates for the lower part of the KB10 and KB11 channel fills indicate that these palaeochannel fragments were abandoned sometime before the late-Roman or early Anglo Saxon period and their overlapping age spans suggest they may have been part of a contemporary channel system. It is noted, however, that the radiocarbon chronology obtained for KB10 (c.cal AD 560-770) and KB14 (c.400-200 cal BC) is inconsistent with the age-sequencing of the palaeochannel remnants depicted in the desk-based mapping exercise which implies that the KB10 channel is truncated by KB9, which in turn is truncated by KB13/14 (Fig. 7.1.18 in Appendix 7.1 shows palaeochannels). It is recognised, however, that these single radiocarbon assays give only a provisional age estimate for their associated fills and that the radiocarbon dates are derived from the upper levels of the respective organic-rich units; further dating assays of material closer to the basal contact with former channel bed materials will facilitate a more robust estimate of the chronology of channel abandonment, while detailed geomorphological field mapping of the palaeochannel morphology is required to resolve the morphostratigraphic relationships of palaeochannel remnants in the Phase 3 extraction area. Notwithstanding these limitations of the data, these new radiocarbon dates for Holocene channel fill deposits constitute evidence of frequent and widespread lateral channel shifts over the past 2500 years at Killerby. Pollen analyses of these fills suggest that floodplain and nearby elevated terrace environments during the late prehistoric and early historic periods at Killerby supported a patchwork of sedge-alder car in wetter palaeochannel settings while drier parts of the valley floor were becoming increasingly cleared of woodland as pasture and, by the early medieval period, cereal cultivation became widespread.

7.6.9 To the south and west of the Phase 3 extraction area Holocene alluvium is also present as local spreads that flank small tributary streams and depressions developed on Late Devensian surfaces including parts of Phase 1, 2 and 4. Alluvium is described by the BGS as comprising a mix of clay, silt, sand and gravel. However, mapping by Mitchell (unpublished data) also indicates that localised spreads of Holocene peat are present in these alluvial settings, most notably in the low-lying parts of Phase 1 and immediately south of Phase 4. An unpublished sediment core from peat deposits lying adjacent to Fiddale Beck in the extreme northern extent of

Phase 1 yielded the following sedimentary sequence (Mitchell and Innes, pers comm.):

- 0-50cm Topsoil
- 50-174cm Peat with seeds, wood, organic detritus
- 174-345cm Chara marl
- 345-400cm Blue/Grey clay.

7.6.10 A preliminary assessment of pollen preservation between 50 and 170cm suggests that much of the sequence dates to the early Holocene (Innes, pers comm.).

7.6.11 This unpublished (Mitchell and Innes) data has now been supplemented by 4 sediment cores (KB2, 3 7 and 8) and associated 14C and pollen assessment. All cores undertaken as part of this study were located in an area of gently undulating terrain over c.250 m2 and produced up to 250 cm of peat, silty peat and organic-rich silt with frequent macrofossil and woody fragments overlying shell-rich marls and, in turn, clean blue-grey fine sands, silt and clay (Table 7.6.1). Three cores have been 14C dated in the lower levels of their basal peat or peaty silt units and these all yielded dates of Lateglacial or very early Holocene age, respectively in KB2 (c.8230-7750 cal BC at 142 cm, SUERC-26092), KB3 (c.9450-9140 cal BC at 230 cm, SUERC-26093) and KB8 (c.12850-12000 cal BC at SUERC-26096 at 230 cm) (see Table 7.6.1). The oldest of these sequences in the basal part of KB8 has an age span that lies within the Windermere Interstadial and has a pollen assemblage, being dominated by grasses with some limited birch scrub (Table 7.6.1-2), that is broadly consistent with the relatively mild but short-lived climatic conditions during this part of the Lateglacial period. Pollen from the upper part of the organic sequence in KB8, between 40-50 cm, record the local presence of a sedge fen and surrounding mixed deciduous woodland with a high proportion of hazel and also alder, oak, pine and elm (Table 7.6.1-2). The presence of alder in this sample may be indicative of sediment deposition sometime after the widely documented rise in alder woodland that occurred sometime shortly after c.5000 cal BC.

7.6.12 The very early Holocene date (c.9450-9140 cal BC) in basal organic sediments of core KB3 is contemporary with a pollen assemblage representative of local open / slack water and a surrounding birch wood and scrubland with stands of pine, hazel and willow, and this assemblage is also characteristic of overlying peat between 110-118 cm (Table 7.6.1-2). Basal peats in core KB2, dated to c.8230-7750 cal BC, are associated with a sedge fen with surrounding hazel, pine and birch woodland (Table 7.6.1-2) and this assemblage is succeeded in overlying silty peat between 170-180 and 110-120 cm by pollen indicative of hazel-dominated woodland with some elm, oak and birch.

7.6.13 In combination, all three of these sediment cores have basal organic-rich sedimentary sequences with dating controls and pollen assemblages that provide a broad confirmation of the vegetation history and inferred chronology obtained by earlier work by Mitchell and Innes (pers. comm.), with the additional evidence in KB8 of deposits that extend into the Lateglacial Windermere Interstadial. The absence of alder in the mixed deciduous woodland assemblages in upper levels of the organic-rich sequences in KB2 and 3 would also point to deposition prior to the alder-rise of c.5000 cal BC. It is recognised, however, that further radiocarbon and palaeoenvironmental analyses are necessary in order to corroborate this provisional chronology, especially since the potential for hardwater errors in the radiocarbon chronologies are significant in these calcareous depositional environments (see, for example, Jones *et al*. 2000).

Summary and recommendations for further investigations

7.6.14 The combination of geomorphological, palaeoecological and radiocarbon analyses conducted in the Phase 2 evaluation at Killerby has demonstrated clear evidence for well-preserved palaeoenvironmental archives spanning parts of the Lateglacial (Windermere Interstadial) (KB8) period, the Mesolithic period c.9000-5000 cal BC (KB2, 3 and 5), the Middle Bronze Age c.1400-1100 cal BC (KB5), the mid-Iron Age c.400-200 cal BC (KB14) and the early Medieval period c.cal AD 400-800 (KB10 and 11). Furthermore, although the investigated palaeochannels in the Phase 3 extraction area (KB9-14) appear to post-date the mid-Iron Age, the presence of additional palaeochannel fragments, that on the basis of morphostratigraphic relationships pre-date the channels investigated here, would suggest that the timescale of channel and floodplain development will extend into earlier parts of the Holocene. It is interesting to note in this respect that alluvial deposits at Brompton-on-Swale, located only 6km upstream of the Killerby study area (Taylor *et al*. 2000), have been dated to the Early Mesolithic and Bronze Age periods as well as the post-medieval period. Alluvial, peat and kettle-fill deposits at Killerby clearly have the potential to bury archaeological remains in an excellent state of preservation, including organic artefacts such as wood, bone and textiles, as well as constituting an important palaeoecological record of former environments and human activity. Indeed, boreholes and evaluation trenching by Northern Archaeological Associates to the west of the Killerby Prospect area revealed buried peat deposits overlying and in-filling hollows that contained faunal remains and flint artefacts. In one hollow an auroch bone was dated to the Early Bronze Age while in another a modified red deer antler was dated to the Late Mesolithic. The excavation and recording of peat-filled depressions and kettle-holes could provide a very rewarding, yet innovative, method for recording and understanding past human activity in the area, and particularly early Holocene colonisation by the first Mesolithic inhabitants. Kettle-holes have never been archaeologically recorded in the UK, whereas in Jylland, Denmark (Aaris-Sørenson *et al*. 2007) such features have produced Late Pleistocene reindeer bones of an animal killed with a flint arrowhead, and associated flints and other tools as well as a complete environmental sequence of the Late Glacial. There is good potential for such features within the impact area given the complex mosaic of glacial lakes that have been recorded for this part of Yorkshire (Long *et al*. 2004, 15) and has acquired a nickname of the 'Yorkshire Lake District' to describe the late Glacial environment of the Swale - lower Ure and Humber lowlands at this time.

7.6.15 Accordingly, in view of the results of the Phase 1 and 2 evaluations at Killerby the following recommendations are made for further geoarchaeological analyses:

1. Geomorphological mapping and topographic survey of selected areas of the Phase 1, 2 and 3 extraction areas in order to resolve (i) the basin morphology and spatial extent of former wetland settings in the area of KB2/3/7/8 and (ii) Holocene river terrace and palaeochannel morphostratigraphy in the Phase 3 extraction area – this is intended to clarify the age-sequencing of dated and undated palaeochannel fragments on the alluvial surfaces.

2. Re-core sedimentary sequences KB2, 3, 5, 8, 10, 11 and 14 and conduct full palaeoecological analysis and radiocarbon dating on the organic-rich deposits described in Table 2 and test those palaeochannels in the southern part of the Phase 3 extraction area that are older than those remnants cored by KB10, 11 and 14 and conduct selectively analyse as with the cores mentioned above.

3. Conduct targeted archaeological excavation of peaty and organic-rich deposits identified as dating to the Lateglacial and Mesolithic periods; these comprise kettle-hole fill sediments at KB8 (26-233 cm) and deposits infilling the low-lying basin at core sites KB2 (44-146 cm), KB3 (40-250 cm) and KB5 (152-252 cm – note that this depth range will also encompass sediments dating to the Bronze Age) and the peat deposit in Field 3 previously evaluated (See Appendices 7.1 and 7.3).

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Table 7.6.1: Sediment logs, ^{14}C dates and pollen assemblages from Killerby cores KB1-KB14

Sediment Core (grid ref)	Unit Depth (cm)	Unit thickness (cm)	Description	^{14}C dating	Summary of pollen assemblage (see below for full details)
KB1 (SE 26277 95620)					
	0-25	25	Topsoil		
	25-68	43	Mid-brown to orange slightly silty medium sand		
	68-77	9	Mottled grey-brown medium-coarse sand		
	77-120	43	Grey silty fine sand with occasional laminations of fine sandy silt		
	120-170	50	Laminated grey / dark grey silty fine sand and silty clay		
	170-200+	30+	As above, but with coarse sand lenses		
KB2 (SE 26813 95714)					
	0-16	16	Peaty topsoil		
	16-44	28	Dark grey friable silty peat with macrofossils		
	44-118	74	Compact black silty peat with frequent macrofossils and wood fragments		110-118 cm: Sedge fen with surrounding hazel / pine / birch woodland
	118-132	14	Light grey fine sandy silt with frequent macrofossils		
	132-146	14	Dark brown silty peat with frequent macrofossils	c.8230-7750 cal BC (SUERC-26092) at 142 cm	132-140 cm: Sedge fen with surrounding hazel / pine / birch woodland
	146-300+	154+	Mottled light grey / beige calcareous fine sandy silt, frequent shell fragments below 160cm, intact shell below 220cm		

KB3 (SE 26975 95747)					
	0-40	40	Peaty topsoil		
	40-120	80	Compact dark brown silty peat, frequent macrofossils, humified above 80cm		110-120 cm: Hazel–dominated woodland, some elm, oak and birch
	120-188	68	Dark brown silty peat with occasional shell fragments, becoming lighter brown and humified below 160cm		170-180: Hazel–dominated woodland, some elm, oak and birch
	188-215	27	Dark brown humified peaty silt		
	215-220	5	Laminated black organic-rich silt and light brown silt		
	220-250	30	Dark grey silty peat, well-humified with occasional shell fragments, occasional lenses of organic-rich silt	c.9450-9140 cal BC (SUERC-26093) at 230 cm	230-240 cm: Open / slack water, surrounding birch wood and scrubland, some pine, hazel and willow
	250-270	20	Light grey calcareous silt with frequent shell fragments		
	270-300+	30+	Dark grey clean clayey silt		
KB4 (SE 26265 95343)					
	0-30+		Brown topsoil and sandy gravel		
KB5 (SE 25702 95507)					
	0-28	28	Sandy topsoil		
	28-71	43	Medium brown clayey silt with fine gravel inclusions		
	71-95	24	Dark grey clayey silt with fine gravel inclusions		
	95-152	57	Mid-brown clayey silt, occasional fine sandy lenses		
	152-157	5	Dark brown peaty silt	c.1420-1130 cal BC (SUERC-26094) at 152-157 cm	152-157cm: Alder and mixed woodland (inc. hazel, pine and oak), open grassland and pasture

	157-231	74	Mid-brown silty clay with thin lenses of peaty silt		
KB5 (cont)	231-252	21	Dark brown humified silty peat, becoming siltier down-profile	c.9660-9240 cal BC (SUERC-26095) at 231-235 cm	231-252cm: Sedge fen, some birch woodland & scrub
	252-270	18	Dark grey silty clay with thin lenses (1-5mm) of organic-rich silt		
	270-278	8	Grey silty clay with occasional organic inclusions		
	278-328	50+	Fine gravelly silty clay, becoming sandy gravel down-profile		
KB6 (SE 26141 95585)					
	0-22	22	Dark brown peaty topsoil		
	22-40	18	Orange calcareous silt / marl		
	40-55	15	Dark brown humified silty peat		
	55-73	18	Mottled light brown / mid grey sandy silt, traces of fine lamination		
	73-150+	77+	Mottled grey-brown clean silty clay, becoming sandy down-profile		
KB7 (SE 26825 95801)					
	0-60	60	Dark brown humified peat		
	60-64	4	Brown organic-rich silt		
	64-72	8	Grey-brown silty peat with frequent macrofossils		
	72-175	103	Light grey / beige marl with frequent macrofossils, lenses of med-coarse sand below 110cm		
	175-350	175+	Mid-light grey fine sandy silty clay, becoming light-blue and laminated with med-coarse sands down-profile, occasional shell fragments		

KB8 (SE 26952 95825)					
	0-26	26	Topsoil		
	26-132	106	Dark brown slightly silty humified peat, occasional macrofossils		40-50 cm: Sedge fen with surrounding mixed deciduous woodland (especially hazel, but also alder, oak, pine and elm)
	132-187	55	Organic-rich brown-grey silt / marl with frequent shall and macrofossils, becoming laminated with silty fine sand below 150cm		
	187-210	23	Brown peaty silt, humfied with frequent shell fragments and macrofossils		
	210-233	23	Light brown / beige laminated silt and fine sandy silt, frequent macrofossils	c.12850-12000 cal BC (SUERC-26096) at 230 cm	220-230 cm: Grasses with some limited birch scrub
KB8 (cont)	233-265	32	Light grey silty fine sand, occasional organic inclusions		
	265-300+	35+	Clean grey silty fine sand		
KB9 (SE 26783 96418)					
	0-25	25	Topsoil		
	25-81	56	Brown fine sandy silt, becoming sandier down-profile		
	81-100+	19+	Mottled range-brown medium-fine sand		
KB10 (SE 26731 96332)					
	0-26	26	Topsoil		
	26-120	94	Brown fine sandy clayey silt, compact, becoming sandier down-profile		
	120-150	30	Dark grey-brown fine sandy silt, occasional oxidised organic flecks and charcoal flecks		
	150-175	25	Dark grey silty peat with frequent macrofossils	c. cal AD 560-770 (SUERC-26097) at 155 cm	155-165 cm: Sedge / alder fen carr
	175-190	15	Dark grey silty fine-medium sand, becoming coarse sand down-		

			profile		
	190+		Gravel		
KB11 (SE 27018 96282)					
	0-28	28	Topsoil		
	28-65	37	Mid-brown fine sandy clayey silt, becoming sandier down-profile		
	65-70	5	Brown medium sand		
	70-100	30	Brown silty fine sand with oxidised organic inclusions		
	100-150	50	Dark brown humified peaty silt, becoming sandy below 140cm and less organic	c. cal AD 430-650 (SUERC-26098) at 112 cm	110-120 cm: Open grassland with pasture and arable
	150+		Gravel		
KB12 (SE 27085 96328)					
	0-30	30	Topsoil		
	30-60	30	Light-medium brown fine sandy clayey silt with Mn flecks, becoming sandy below 50cm		
	60+		Gravel		
KB13 (SE 26615 96630)					
	0-25	25	Topsoil		
	25-60	35	Mid-brown fine sandy silt with oxidised organic inclusions		
	60-133	73	Mid-brown silty fine sand, becoming coarse sand down-profile		
	133+		Gravel		
KB14 (SE 26457 96477)					
	0-25	25	Topsoil		
	25-85	60	Mottled orange-brown silty fine sand with oxidised organic inclusions, Mn staining		
	85-105	20	Mottled dark grey-brown fine sandy silt, becoming sandier down-profile		
	105-128	23	Mottled grey-brown silty medium sand with		

			occasional organic inclusions		
	128-138	10	Mid-grey laminated silty fine sand and medium sand, occasional organic inclusions		
KB14 (cont)	138-153	15	Dark grey humified peat with occasional macrofossils		
	153-160	7	Laminated dark grey silty peat and peaty silt, occasional macrofossils		
	160-175	15	Grey organic-rich clayey silt with fine sand laminations	c. 400-200 cal BC (SUERC-26102) at 164 cm	160-170 cm: Mixed woodland (dominated by hazel and alder), open grassland & heath
	175-200	25	Mid-grey silty fine sand, becoming coarser down-profile, occasional organic inclusions		
	200+		Gravel		

Killerby Prospect Palynological Assessment

By

E-J. Hopla and Dr B.R. Gearey MIfA

Birmingham Archaeo-Environmental

For

Archaeological Research Services Ltd

SUMMARY

7.6.16 This report describes palynological assessment of 12 subsamples from Killerby Prospect, North Yorkshire. Good/moderate preservation and high concentrations of palynomorphs were recorded in all the samples from KB3, KB5, KB8, KB10. Three samples (KB2, 1.10 and 1.32m, KB11, 1.10m) were classed of low concentration and poor/moderate preservation but these samples still contained sufficient pollen for assessment. The pollen spectra indicates that peat accumulation may have commenced during the early Holocene at KB3, 2.30m; KB5, 2.31m, KB8, 2.20m. The other samples are dominated by a range of tree and shrub pollen reflecting deciduous woodland probably dating to the mid-Holocene. Three samples (KB5, 1.52m; KB10, 1.55m and KB11, 1.20m) contain indications of human activity in the form of pollen reflecting open, disturbed habitats and possible cereal cultivation. These samples are likely to date to the later Holocene. The potential for further pollen-analytical work at the site is regarded as high.

INTRODUCTION

7.6.17 Birmingham Archaeo-Environmental were commissioned to undertake a palaeoenvironmental assessment of samples from deposits at Killerby Prospect, North Yorkshire (Waddington et al. 2008). The site is situated to the south-east of Catterick Village with the River Swale to the north. The samples are from organic deposits associated with the floodplain of the River Swale.

METHODS

Pollen Analysis

7.6.18 A total of 12 subsamples were submitted for pollen assessment from sampling locations: KB2, KB3, KB5, KB8, KB10, KB11 and KB14. Pollen preparation followed standard techniques including potassium hydroxide (KOH) digestion, hydrofluoric acid (HF) treatment and acetylation (Moore et al., 1991). At least 125 total land pollen grains (TLP) excluding aquatics and spores were counted for each sample. The concentration and preservation of pollen in each sample was assessed on a five point scale (see Table 7.6.2).

RESULTS

7.6.19 All of the pollen samples provided sufficient counts for palaeoenvironmental assessment. The results are summarised in Table 7.6.2. Percentages are of total land pollen (TLP) unless otherwise stated.

KB2

7.6.20 Two samples were assessed from KB2 (1.10-1.18m and 1.32-1.40m depths). Sufficient counts for assessment were obtained although concentrations were low in both samples. The preservation in the basal sample (1.32m) was also low. The main species recorded were Corylus avellana-type (most likely hazel) which dominated the sample (41%) with Cyperaceae (sedges) (17%) and Poaceae (wild grasses) (11%). Other trees and shrubs were recorded at low values and include Ulmus (elm), Betula (birch), Pinus sylvestris (Scots pine) and Quercus (oak). The upper sample (1.10m) was dominated by the same tree, shrub and herb spectra recorded in the lower sample.

7.6.21 The pollen spectra suggest that sedges were a significant component of the local vegetation, probably in the form of sedge fen on and around the sampling site. There is no evidence in the pollen record for areas of standing/slow flowing water. Hazel, pine and birch would have been growing on the drier areas of the fen and in the wider landscape.

KB 3

7.6.22 Three samples were assessed from KB3 (1.10-1.20, 1.70-1.80 and 2.30-2.40m depths). Sufficient counts for assessment were obtained and concentrations were high to very high in all samples. The preservation in each sample was also extremely good. The basal sample (2.30m) was dominated by Betula (75%) with Pinus, Corylus and Salix (willow) also recorded at low values. Other than Poaceae (24%), herbs were rare. Aquatics included Myriophyllum spicatum (spiked water-milfoil) and Potamogeton-type (pondweed). This sample was dominated by a spore (56% TLP+spores) which could be identified with further analysis.

7.6.23 The two upper samples were dominated by Corylus avellana-type, (93% in the middle sample - 1.70m). Betula fell to trace values at 1.70m but increased (12%) by 1.10m. Ulmus, Quercus, Hedera helix (ivy) and Cyperaceae were also present but at low values.

7.6.24 The high values of Betula in the basal sample indicate the dominance of birch wood/scrubland, perhaps dating to the earlier Holocene. Areas of still or slow flowing water are suggested by the presence of aquatic species such as spiked water-milfoil and it is likely that some of the grasses present were associated with this wetland area (e.g. Phragmites australis – common reed). Hazel has expanded by 1.70m at the expense of birch, possibly reflecting successional processes associated with the spread of deciduous woodland. Other trees were present, but as minor components of the woodland.

KB5

7.6.25 Two samples were assessed from KB5 (1.52-1.57 and 2.31-2.52m depths). Sufficient counts for assessment were obtained and concentrations were excellent in both samples. The preservation in the upper sample was good but slightly less so in the basal sample. The basal sample was dominated by Cyperaceae (37%) along with Betula (30%) and Poaceae (22%).

7.6.26 The upper sample (1.52-1.57m) was also dominated by Cyperaceae (38%) and Poaceae (30%), but Betula has decreased to trace values and Alnus (alder) (13%) has appeared. Other trees included Corylus avellana-type, Pinus, Tilia (lime) and Quercus at low values. A range of herbs including Plantago lanceolata (ribwort plantain), Centaurea nigra (common knapweed), Lactuceae (dandelions) and Apiaceae (the carrot family). Aquatics were present at low values and include Menyanthes (bogbean) and Myriophyllum spicatum.

7.6.27 The implied environment was similar to that in KB2. In the basal sample sedge fen is indicated with few trees or shrubs other than birch. This spectrum may also suggest an early Holocene timeframe. Open areas of grassland are indicated although some of the grasses possibly derive from wetland grasses such as Phragmites (common reed). The upper sample is also dominated by sedges but alder has expanded onto the wetter soils. Grasses have increased slightly and there is evidence in the form of ribwort plantain, common knapweed and dandelions for open, possibly ruderal habitats on the drier soils.

KB8

7.6.28 Two samples were assessed from KB8 (0.40-0.50 and 2.20-2.30m depths). Sufficient counts for assessment were obtained and concentrations were very good to excellent in both samples. Preservation was considerably lower in the upper sample. The basal sample was dominated by Poaceae (89%) with Betula (6%) Pinus, Corylus, Salix and Calluna (heather) are recorded but at trace values. Other herbs were extremely rare with only single grains of Filipendula (meadowsweet) and Cyperaceae present.

7.6.29 The upper sample was far more diverse with Cyperaceae (28%), Corylus avellana-type (22%) and Poaceae (20%) dominating. Other trees present included Ulmus, Alnus, Pinus, Quercus and Tilia. Herbs were rare but include Thalictrum flavum (common meadow-rue), Plantago lanceolata and Filipendula at trace values. Pteropsida (ferns) attain their highest values in this sample (27%TLP+spores).

7.6.30 The basal sample indicates open grassland with at the most some patches of scrubby birch. This is likely to reflect an early Holocene landscape. The local environment has changed quite dramatically by 0.40m with the development of sedge fen on and around the sampling site, with herbs such as meadow-rue and meadowsweet present. Areas of mixed deciduous woodland dominated by hazel are inferred for the dryland areas.

KB10

7.6.31 One sample was assessed from KB10 (1.55-1.65m) and contained very good to excellent concentration and preservation. The pollen spectra identified was similar to KB5 (1.52-1.57m) with Poaceae (28%), Cyperaceae (26%) and Alnus (13%) reflecting a sedge-alder fen carr environment. Herbs such as Potentilla (tormentil) and Apiaceae suggest herb communities typical of fen environments.

KB11

7.6.32 One sample was assessed from KB11 (1.10-1.20m). The concentration was ranked as medium and the preservation was low-medium but a sufficient count for assessment were obtained Poaceae (35.6%) and Cyperaceae (30%) were dominant. Plantago lanceolata was recorded at much higher values (13%) in this sample with other herbs including Lactuceae, Rumex (docks), Urtica (nettles), Ranunculus-type (buttercups), Mentha (mint) and Caryophyllaceae (pink family).

7.6.33 P. lanceolata is an indicator of open areas and is a classic 'anthropogenic indicator' in pollen diagrams (sensu Behre 1981). It is likely to reflect pastoral habitats probably associated with human agriculture/settlement. A single grain of Secale cereale (rye) was also recorded. The impression is therefore of a treeless, open landscape with evidence for both pastoral and arable environments.

KB14

7.6.34 One sample was assessed from KB14 (1.60-1.70m). A sufficient count for assessment was obtained although the concentration was low and the preservation medium. Calluna (heather, ling) (25%) dominated with Corylus (13%), Alnus (13%) and other trees include Pinus, Ulmus, Quercus, Betula, Alnus and Fraxinus. Aside from Poaceae (16%) and Cyperaceae (12%), herbs were rare but included Rumex, Rosaceae (the rose family) and Plantago lanceolata.

7.6.35 The sample indicates a landscape of patchy mixed woodland but with some open grassy areas. The presence of heather/ling suggests heathland, or perhaps the presence of this species on the drier areas of the wetland.

CONCLUSIONS

7.6.36 Assessment of the samples from Killerby indicates good/moderate preservation and high concentrations of palynomorphs in all the samples from KB3, KB5, KB8, KB10. Three samples (KB2, 1.10 and 1.32m, KB11, 1.10m) were classed of low concentration and poor/moderate preservation but these samples still contained sufficient pollen for assessment.

7.6.37 Three of the basal samples (KB3, 2.30m; KB5, 2.31m, KB8, 2.20m) are dominated by herbaceous taxa and birch, possibly indicating an early Holocene timeframe prior to the expansion of other deciduous trees. The presence of high values for trees and shrubs including hazel, in the other samples would generally imply that most of the sequences cover at least part of the mid-Holocene. It is perhaps notable that Alnus is recorded in four of the samples (KB5, 1.52m; KB8, 0.40m; KB10, 1.55m and KB14, 1.60m). This species tends to dominate floodplain environments from around 7000 BP which could imply that these deposits cover at least part of this timeframe. The radiocarbon dating will of course clarify the chronological span of the sequences.

7.6.38 Palynological evidence for human activity is recorded in three samples (KB5, 1.52m; KB10, 1.55m and KB11, 1.20m). This takes the form of cereal pollen and indicators of open, ruderal habitats. KB11 in particular is dominated by herbaceous taxa including relatively high percentages of ribwort plantain and a grain of Secale cereale. This sample is likely to reflect a later Holocene landscape.

7.6.39 The pollen assessment thus suggests that the potential for further palynological analyses at the site should be regarded as high. Further assessment of these deposits for plant macrofossil and beetle content should be considered if and when conditions permit the recovery of larger sample sizes.

ARCHIVE

7.6.40 The samples and all electronic and paper records pertaining to the work are held at BA-E. These samples will be retained until further notice.

REFERENCES

Behre, K.E. 1981. The interpretation of anthropogenic indicators in pollen diagrams. Pollen et Spores 23, 225-243.

Moore, P.D., Webb, J.A. & Collinson, M.E. 1991. Pollen Analysis, 2nd Edition. Blackwell Scientific Publications, Oxford.

Waddington, C., Passmore, D., Burrill, C. and Johnson, S. 2008. Killerby Prospect Historic Environment Assessment. ARS Ltd Report.

Core / Sample	Main pollen species	TLP	Concentration	Preservation
KB2 1.10-1.18m	Corylus avellana-type (52%), Pinus sylvestris (6%), Ulmus (5%), Betula (5%), Cyperaceae (17%), Poaceae (14%)	132	Low (2)	Medium (3)
KB2 1.32-1.40m	Corylus avellana-type (41%), Pinus (6.1%), Cyperaceae (32%), Poaceae (11%)	131	Low (2)	Poor (2)
KB3 1.10-1.20m	Corylus avellana-type (73%), Betula (12%), Ulmus (5%), Cyperaceae (4.1%), Pteropsida (18%)	146	High (4)	Good (4)
KB3 1.70-1.80m	Corylus avellana-type (93.3%), Betula, Ulmus, Pinus, Cyperaceae and Poaceae at trace values	150	High (4)	Good (4)
KB3 2.30-2.40m	Betula (75%), Poaceae (16%), Pinus, Corylus, Salix, Filipendula at trace values Unknown spore (56% TLP+spores)	153	Very high (5)	Good (4)
KB5 1.52-1.57m	Alnus (13%), Corylus (7%), Cyperaceae (38%), Poaceae (30%) Other herbs include Apiaceae, Plantago lanceolata, Centaurea nigra	149	Very high (5)	Good (4)

	Aquatics include Myriophyllum alterniflorum and Sparganium indet. 3 possible cereal grains			
KB5 2.31-2.52m	Betula (30%), Cyperaceae (37%), Poaceae (22%), Unknown spore (51% TLP+spores)	136	Very high (5)	Medium (3)
KB8 0.40-0.50m	Corylus avellana-type (22%), Betula (8%), Alnus (5.3%), Cyperaceae (28%), Poaceae (20%) Pteropsida (27% TLP+spores)	152	Very high (5)	Poor-Moderate (2/3)
KB8 2.20-2.30m	Betula (6%), Poaceae (89%)	149	High (4)	Good (4)
KB10 1.55-1.65m	Alnus (13%), Corylus avellana-type (9%), Poaceae (28%), Cyperaceae (26%), Plantago lanceolata (5%) Other herbs include Potentilla, Rosaceae, Rumex, Artemesia	152	Very high (5)	Good (4)
KB11 1.10-1.20m	Poaceae (36%), Cyperaceae (30%), Plantago lanceolata (13%) A single cereal grain (probably Arvena) and a single grain of Secale cereale. Other herbs include Lactuceae, Rumex, Ranunculus type, Mentha and	132	Moderate (3)	Poor-Moderate (2/3)

	Caryophyllaceae			
KB14 1.60-1.70m	Calluna (25%), Betula (8%),Corylus avellana-type (13%), Alnus (13%), Poaceae (16%), Cyperaceae (12%)	126	Low (2)	Moderate (3)

Table 7.6.2 Details of Killerby pollen assessments

RADIOCARBON DATING CERTIFICATES AND CALIBRATION PLOTS

Prepared by Scottish Universities Environmental Research Centre

For

Archaeological Research Services Ltd

Scottish Universities Environmental Research Centre
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RADIOCARBON DATING CERTIFICATE

30 October 2009

Laboratory Code	SUERC-26093 (GU-19947)
Submitter	Archaeological Research Services Ltd Angel House Portland Square Bakewell, Derbyshire DE45 1HB
Site Reference	Killerby
Context Reference	2.30m
Sample Reference	KB3
Material	Bulk peat : Humic Acid Dated
δ^{13}C relative to VPDB	-33.1 ‰
Radiocarbon Age BP	9800 ± 65

N.B. 1. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting

statistics on the sample, modern reference standard and blank and the random machine error.

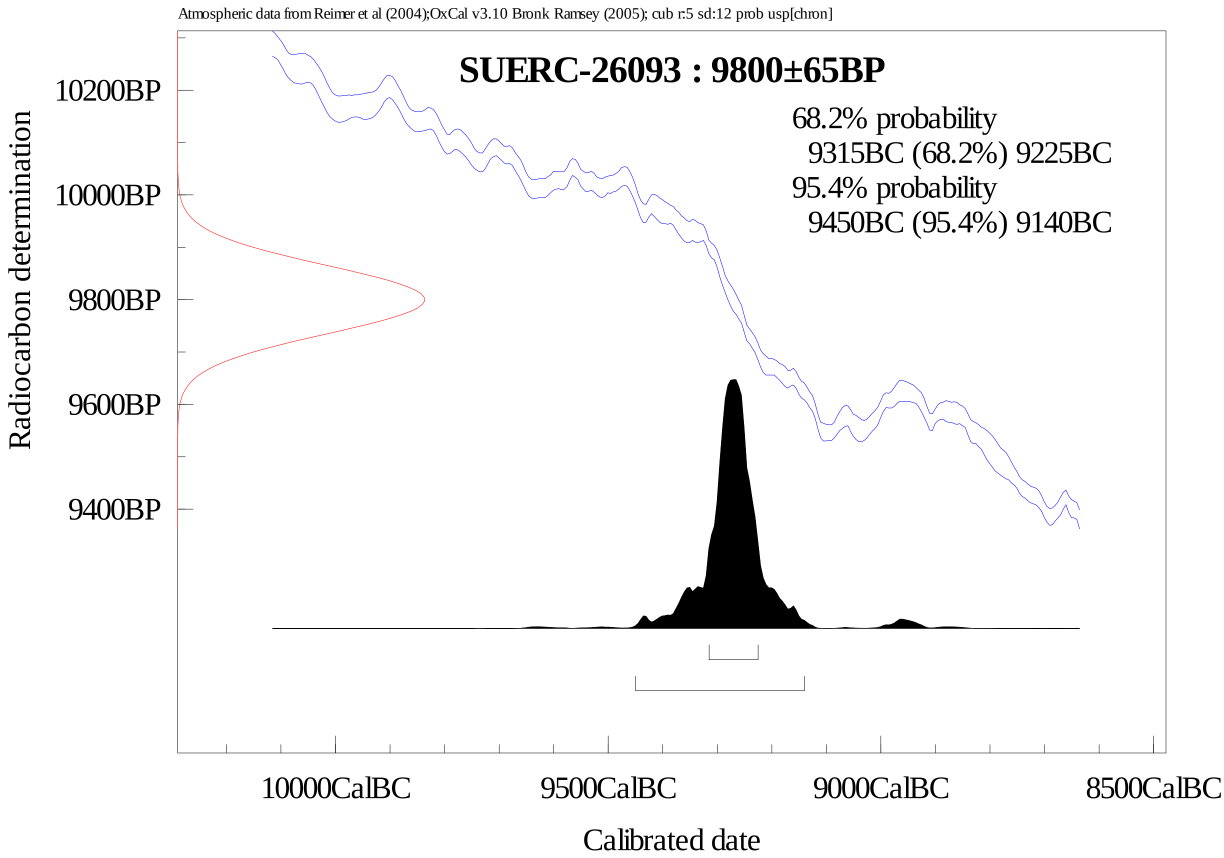
2. The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal3).

3. Samples with a SUERC coding are measured at the Scottish Universities Environmental Research Centre AMS Facility and should be quoted as such in any reports within the scientific literature. Any questions directed to the Radiocarbon Laboratory should also quote the GU coding given in parentheses after the SUERC code. The contact details for the laboratory are email g.cook@suerc.gla.ac.uk or Telephone 01355 270136 direct line.

Conventional age and calibration age ranges calculated by :- Date :-

Checked and signed off by :- Date :-

Calibration Plot



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RADIOCARBON DATING CERTIFICATE

30 October 2009

Laboratory Code SUERC-26094 (GU-19948)

Submitter Archaeological Research Services Ltd
Angel House
Portland Square
Bakewell, Derbyshire
DE45 1HB

Site Reference Killerby

Context Reference 1.52-57m

Sample Reference KB5

Material Bulk peat : Humic Acid Dated

$\delta^{13}C$ relative to VPDB -29.3 ‰

Radiocarbon Age BP 3040 ± 45

N.B. 1. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting

statistics on the sample, modern reference standard and blank and the random machine error.

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Conventional age and calibration age ranges calculated by :- Date :-

Checked and signed off by :- Date :-

University of Glasgow

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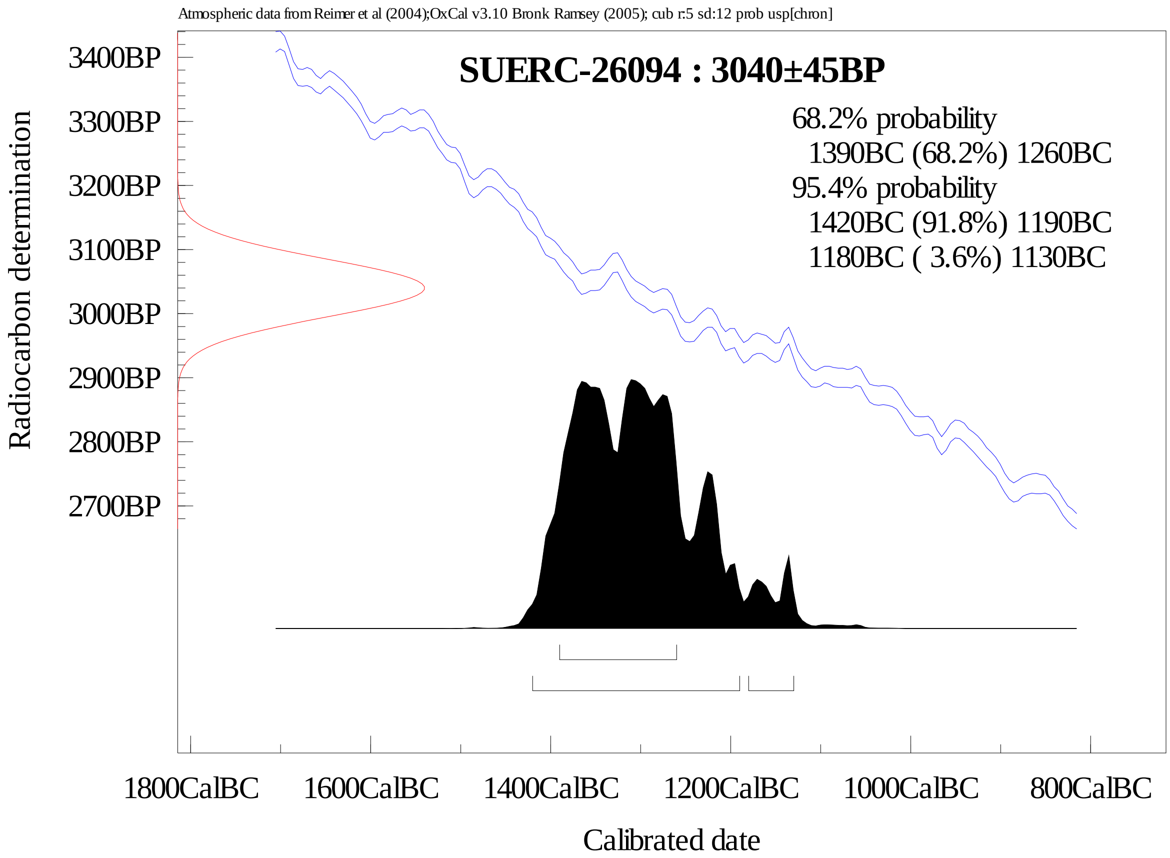
Calibration Plot



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RADIOCARBON DATING CERTIFICATE

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Laboratory Code	SUERC-26095 (GU-19949)
Submitter	Archaeological Research Services Ltd Angel House Portland Square Bakewell, Derbyshire DE45 1HB
Site Reference	Killerby
Context Reference	2.31-52m
Sample Reference	KB5
Material	Bulk peat : Humic Acid Dated
δ^{13}C relative to VPDB	-27.9 ‰
Radiocarbon Age BP	9885 ± 65

N.B. 1. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting

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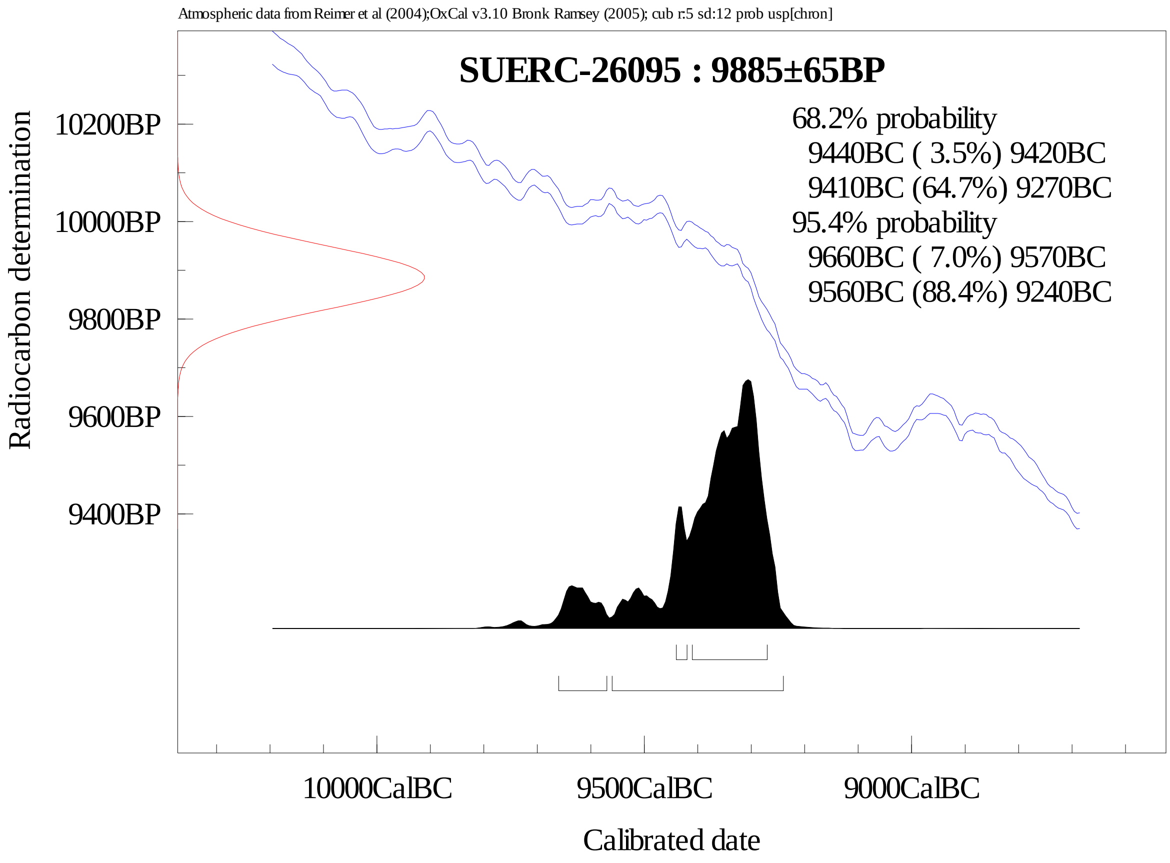

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RADIOCARBON DATING CERTIFICATE

30 October 2009

Laboratory Code	SUERC-26096 (GU-19950)
Submitter	Archaeological Research Services Ltd Angel House Portland Square Bakewell, Derbyshire DE45 1HB
Site Reference	Killerby
Context Reference	2.30m
Sample Reference	KB8
Material	Bulk peat : Humic Acid Dated
$\delta^{13}C$ relative to VPDB	-24.1 ‰
Radiocarbon Age BP	12325 ± 80

N.B. 1. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting

statistics on the sample, modern reference standard and blank and the random machine error.

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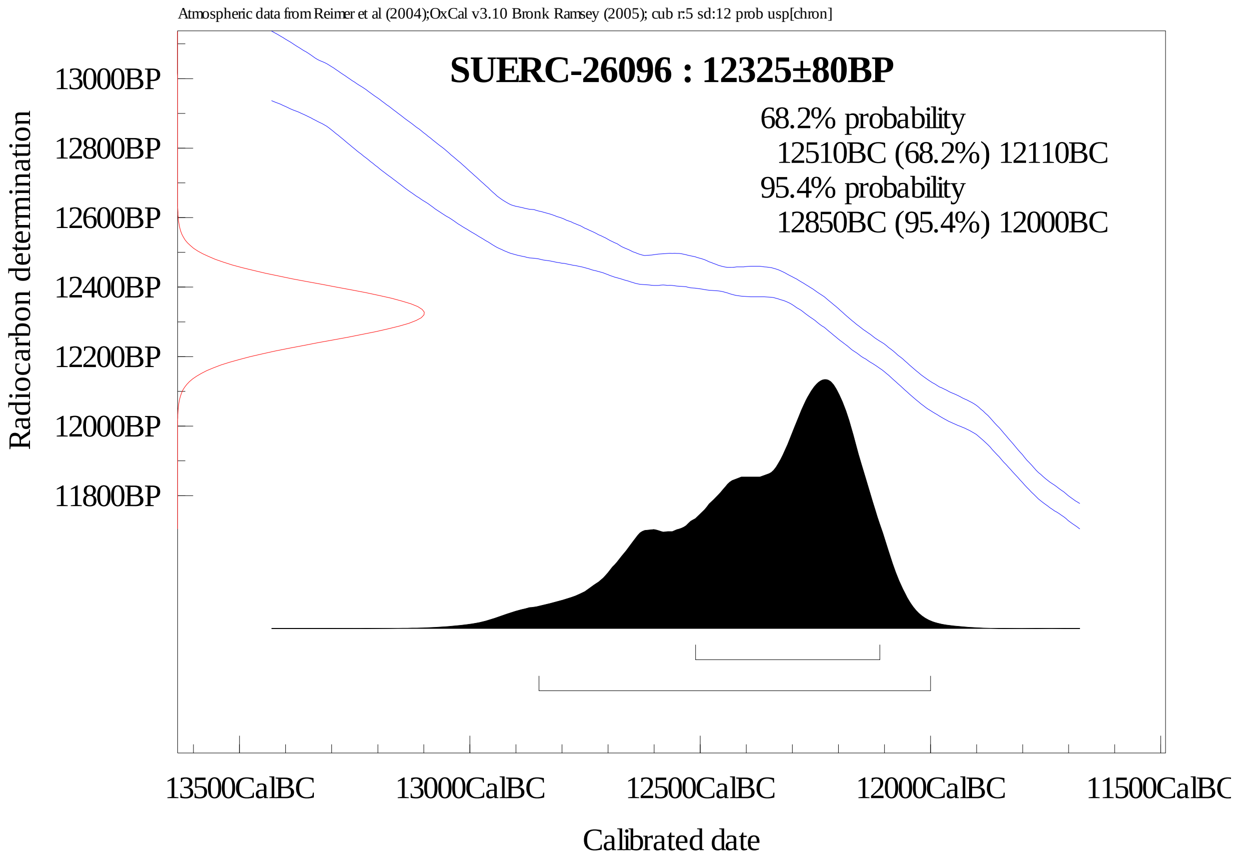

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RADIOCARBON DATING CERTIFICATE

30 October 2009

Laboratory Code	SUERC-26097 (GU-19951)
Submitter	Archaeological Research Services Ltd Angel House Portland Square Bakewell, Derbyshire DE45 1HB
Site Reference	Killerby
Context Reference	1.55m
Sample Reference	KB10
Material	Bulk peat : Humic Acid Dated
δ^{13}C relative to VPDB	-29.4 ‰
Radiocarbon Age BP	1395 ± 45

N.B. 1. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting

statistics on the sample, modern reference standard and blank and the random machine error.

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Conventional age and calibration age ranges calculated by :- Date :-

Checked and signed off by :- Date :-

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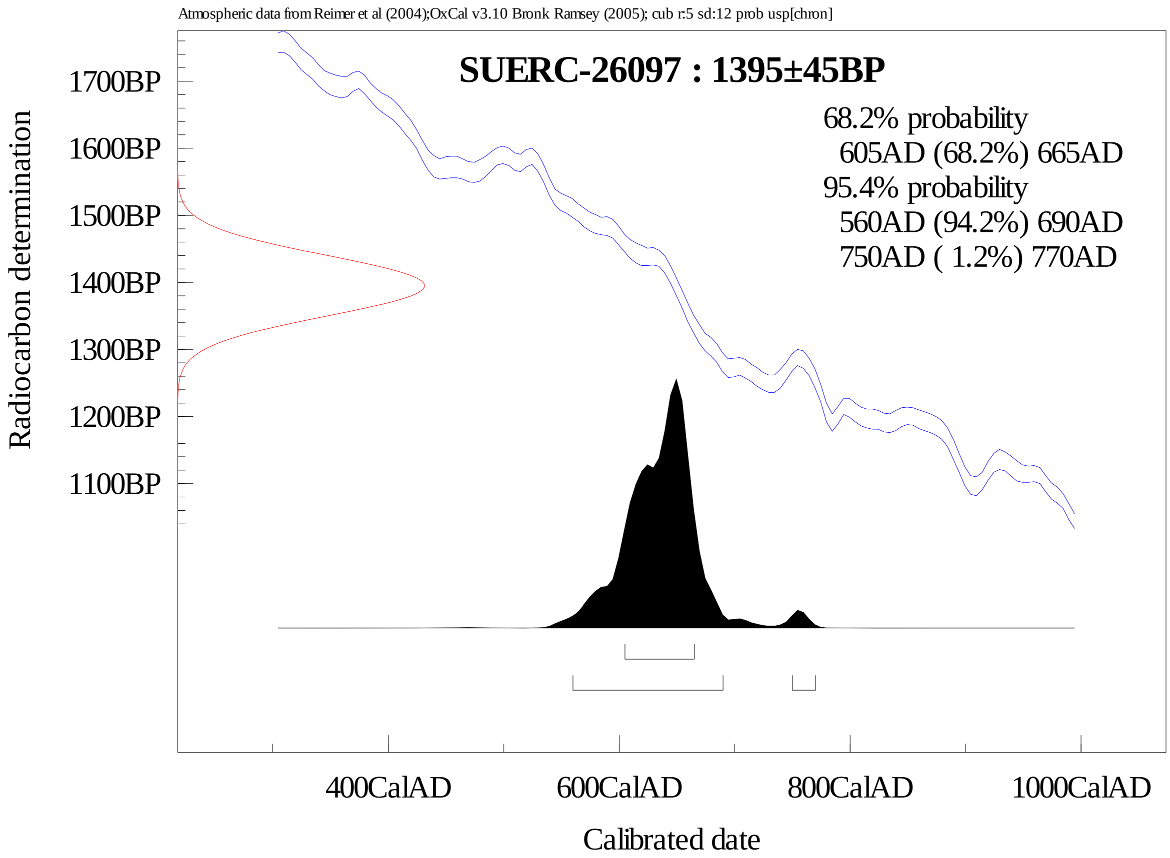
Calibration Plot



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RADIOCARBON DATING CERTIFICATE

30 October 2009

Laboratory Code	SUERC-26098 (GU-19952)
Submitter	Archaeological Research Services Ltd Angel House Portland Square Bakewell, Derbyshire DE45 1HB
Site Reference	Killerby
Context Reference	1.12m
Sample Reference	KB11
Material	Bulk peat : Humic Acid Dated
δ^{13}C relative to VPDB	-29.5 ‰
Radiocarbon Age BP	1505 ± 45

N.B. 1. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting

statistics on the sample, modern reference standard and blank and the random machine error.

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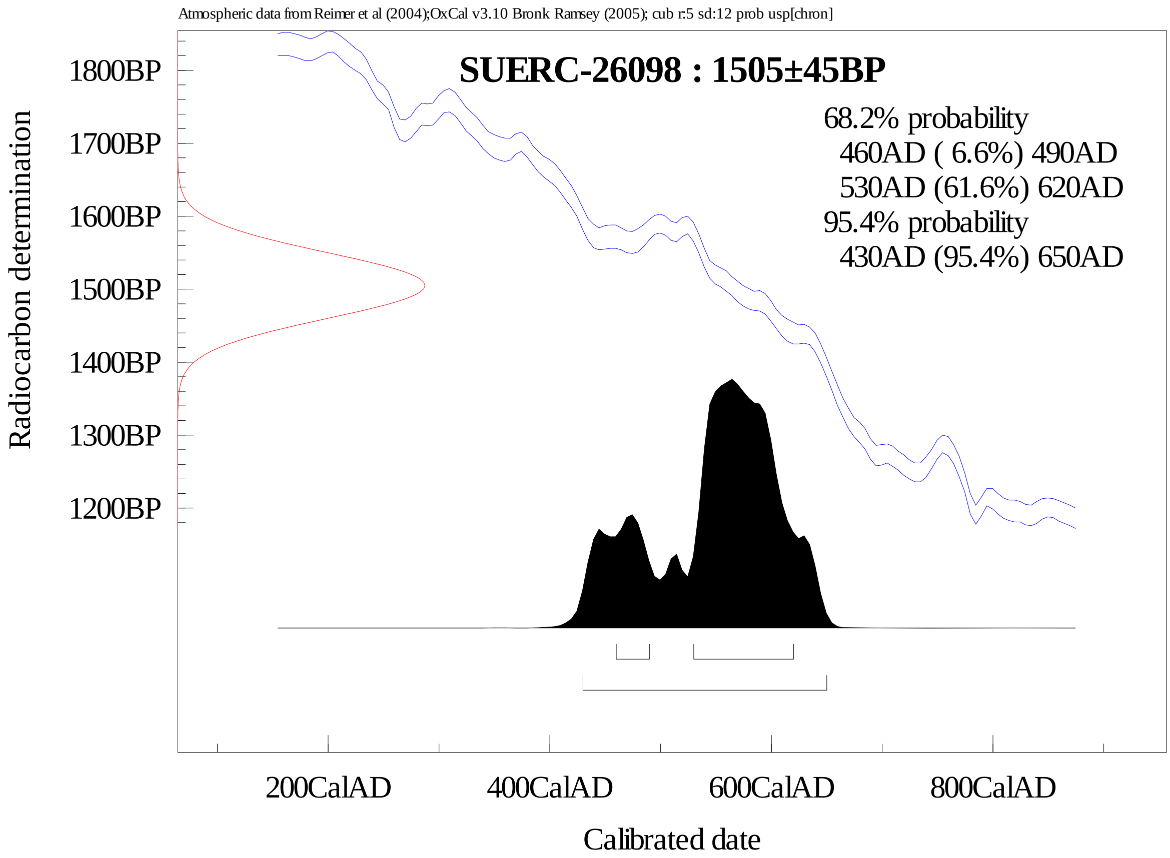
Conventional age and calibration age ranges calculated by :- Date :-

Checked and signed off by :- Date :-

Calibration Plot



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RADIOCARBON DATING CERTIFICATE

30 October 2009

Laboratory Code SUERC-26102 (GU-19953)

Submitter Archaeological Research Services Ltd

Angel House

Portland Square

Bakewell, Derbyshire

DE45 1HB

Site Reference Killerby

Context Reference 1.64m

Sample Reference KB14

Material Bulk peat : Humic Acid Dated

$\delta^{13}C$ relative to VPDB -29.3 ‰

Radiocarbon Age BP 2240 ± 45

N.B. 1. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error.

2. The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal3).

3. Samples with a SUERC coding are measured at the Scottish Universities Environmental Research Centre AMS Facility and should be quoted as such in any reports within the scientific literature. Any questions directed to the Radiocarbon Laboratory should also quote the GU coding given in parentheses after the SUERC code. The contact details for the laboratory are email g.cook@suerc.gla.ac.uk or Telephone 01355 270136 direct line.

Conventional age and calibration age ranges calculated by :- Date :-

Checked and signed off by :- Date :-

University of Glasgow

The University of Glasgow, charity number SC004401

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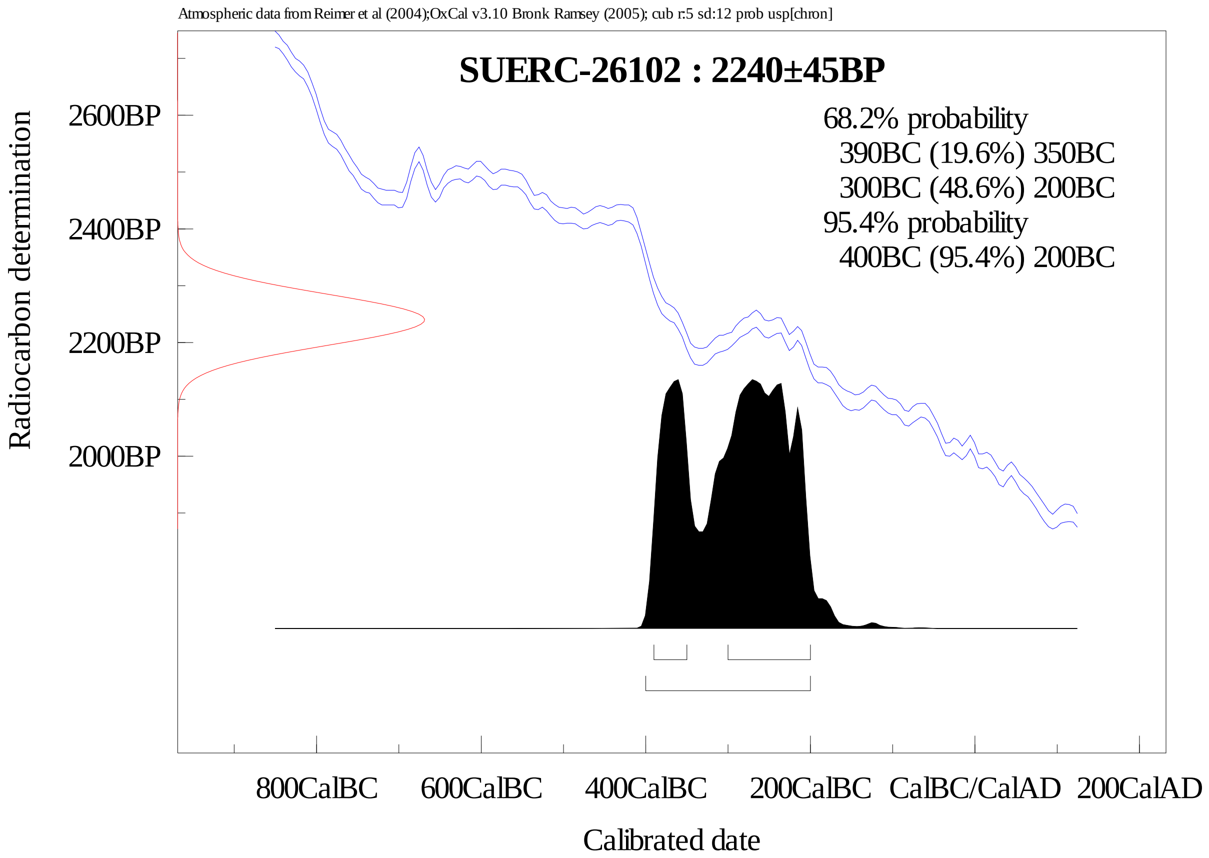
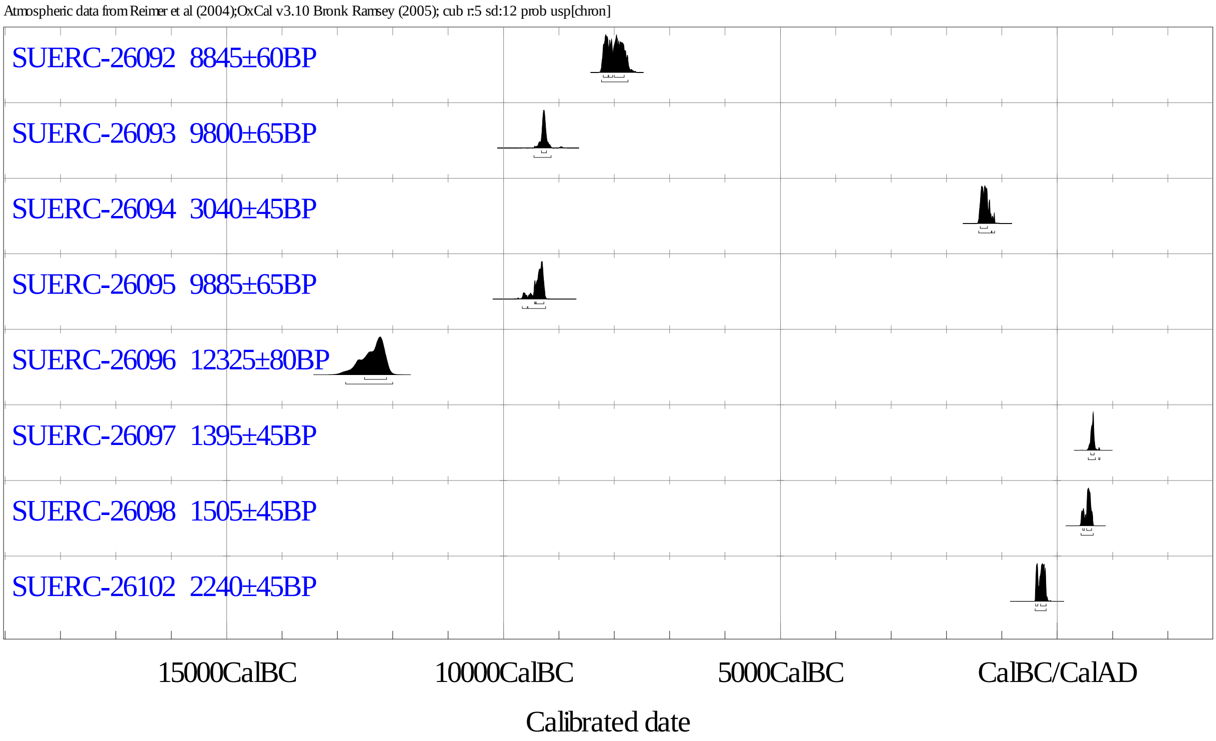
Calibration Plot




Atmospheric data from Reimer et al (2004);OxCal v3.10 Bronk Ramsey (2005); cub r:5 sd:12 prob usp[chron]
SUERC-26092 8845±60BP
SUERC-26093 9800±65BP
SUERC-26094 3040±45BP
SUERC-26095 9885±65BP
SUERC-26096 12325±80BP
SUERC-26097 1395±45BP
SUERC-26098 1505±45BP
SUERC-26102 2240±45BP
15000CalBC
10000CalBC
5000CalBC
CalBC/CalAD
Calibrated date