Netherlands Journal of Geosciences — Geologie en Mijnbouw | **88 – 2** | **117 - 125** | **2009**

Holocene, Weichselian Late-glacial and earlier Pleistocene deposits of the upper Cam valley at the Hinxton Genome Campus, Cambridgeshire, UK

S. Boreham* & C.J. Rolfe

Quaternary Palaeoenvironments Group, Department of Geography, University of Cambridge, Downing Place, Cambridge CB2 3EN.

* Corresponding author. Email: sb139@cam.ac.uk.

Manuscript received: March 2009; accepted: July 2009

Abstract

A section through Pleistocene deposits and temporary exposures of valley-side and valley-fill Late-glacial and Holocene sediments in the upper Cam valley at Hinxton Genome Campus, Cambridgeshire, UK are described. Stratigraphy, radiocarbon dating and pollen analysis are used to create a model of sediment transport, landscape change and vegetation history at the site. This study offers a new understanding of the stratigraphy and context of the Holocene, Weichselian Late-glacial and earlier Pleistocene deposits of the upper Cam valley, and provides an insight into valley-side sediment transport processes and the three-dimensional sediment architecture of the valley-fill sediments.

Keywords: Holocene, Weichselian Late-glacial, Pleistocene, Cam valley

Introduction

This study, carried out in 2002/03, aimed to investigate the stratigraphy and nature of the Holocene and Weichselian Late-glacial deposits of the upper Cam valley exposed by archaeological excavations at two adjacent sites (Hinxton Hall and Hinxton Riverside) south of the Hinxton Genome Campus, Cambridgeshire, UK (Fig. 1a). The Hinxton Hall site was located on a hitherto unrecognised gravel river terrace remnant (c. 35 m O.D.) at the foot of a chalky valley-side slope some 150 m northeast of the River Cam (TL 499442). The Hinxton Riverside site was located nearby on the floodplain of the River Cam (TL 498442) at c. 32 m O.D. (Fig. 1b). Sediments exposed in five geological sections (I-V) have been described, and lithofacies codes (Miall, 1977, 1985) have been applied to the sediments to help with interpretation. In addition, borehole records collected as part of 'The Cambridge Project' (Boreham, 2002) have been used to place the data from the Hinxton Genome Campus into context, and provide a better understanding of the Pleistocene stratigraphy of the upper Cam valley.

Geological setting

Background

At Cambridge the River Cam drains a c. 1000 km^2 catchment of low chalky hills north of London. The River Cam is a tributary of the River Great Ouse, which flows c. 50 km north of Cambridge through Fenland in a largely artificial channel to enter the southern North Sea at King's Lynn on the Wash.

The geology of the upper valley of the River Cam was first described in detail by White (1932), who recognised deep buried channel-forms beneath the modern north-south alignment of the river. The 'valley gravels' of the Cam system were separated by elevation into numbered terraces (3rd, 2nd, 1st) using a morphostratigraphic paradigm. The stratigraphy of the upper Cam was investigated by Baker (1977), who described various tills, outwash gravels, and glacio-lacustrine deposits of probable Elsterian (MIS 12) age. At locations to the south of Ickleton, Baker identified two superimposed and deeply incised buried channels ('tunnel valleys'), the first filled by till and the second containing glacial lake sediments. Baker found the later deposits of the upper Cam valley hard to separate, and grouped all post-Elsterian deposits as either valley gravels, periglacially derived diamicts, or Holocene alluvium.

https://doi.org/10.1017/S0016774600000925 Published online by Cambridge University Press

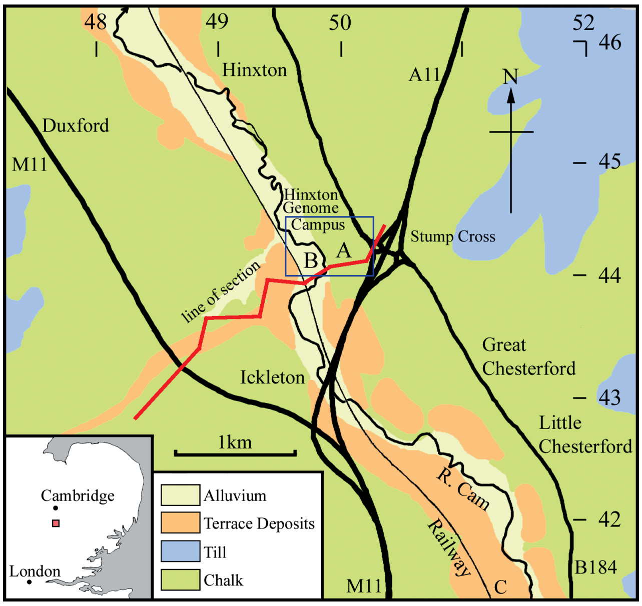

Fig. 1a. Map of the upper Cam valley around Hinxton Genome Campus, showing the simplified geology taken from the Saffron Walden Sheet (205), and line of section shown in Fig. 2. Sites discussed in the text are indicated thus; A – Hinxton Hall, B – Hinxton Riverside, C – Bordeaux Farm Pit. The Ordnance Survey 1 km grid is shown. Reproduced from the Pathfinder 1027 1 : 25 000 map with the kind permission of the Ordnance Survey. ©Crown copyright Ordnance Survey. All rights reserved. Reproduced from the Saffron Walden Sheet (205) British Geological Survey.

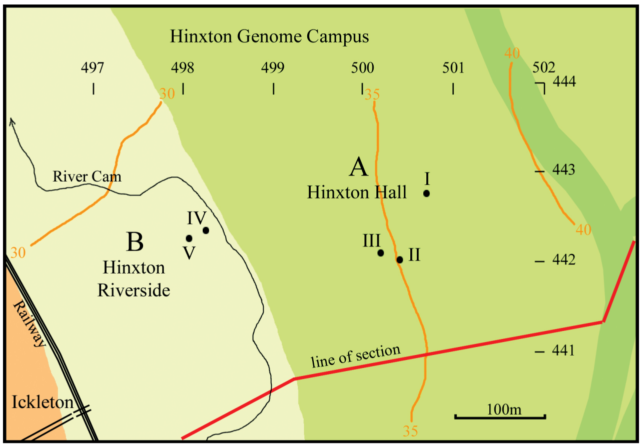

Fig. 1b. Location of Sections I-V at Hinxton Hall and Hinxton Riverside. The Ordnance Survey 100 m grid and contours (5 m interval) are shown.

The lithostratigraphy of the Pleistocene deposits in the valley of the River Cam was described by Boreham in Bowen (1999). Glacial sediments of the Cam valley were correlated with various members of the glaciogenic Lowestoft Formation (LF) of presumed Elsterian (MIS 12) age. Glacial till on the surrounding hills was attributed to the Barrington Works Member (LF), whilst glaciolacustrine sediments occupying deeply incised buried channels were correlated with the Wicken Bonhunt Member (LF). Glacial gravels filling 'tunnel valleys' were ascribed to the Observatory Member (LF).

Post-Elsterian fluvial sediments were placed in the fluviogenic Cam Valley Formation (CVF), including the elevated terrace gravels of the Bordeaux Pit Member. The 3rd Terrace Deposits at the stratotype Bordeaux Farm Pit, near Great Chesterford (location C – Fig. 1a), produced mollusc and vertebrate faunas indicative of cool conditions (Marr, 1926, Sparks, 1955). Apart from being of probable Middle Pleistocene age, dating of these deposits remains problematic. The 2nd Terrace Deposits of the River Cam were correlated with the Middle Weichselian (MIS 3) Sidgwick Avenue Member (CVF), based on the stratotype in west Cambridge (Lambert et al. 1963). All Holocene deposits, including peat and alluvium, were placed in the Fenland Formation.

The stratigraphy of the upper Cam sequence fits well with other parts of the Cam valley system. The stratigraphic units proposed in Bowen (1999) allow correlation with the neighbouring East Anglian and Fenland river valleys such as the Great Ouse, Nene and Lark, although the details are sometimes problematic. The nature and position of the upper Cam, a relatively small stream, within a degraded sub-glacial drainage system, means that many of the older fluvial deposits are potentially fragmented and periglacially modified.

The bedrock in the study area comprises the Cretaceous Nodular Chalk Formation overlain by the New Pit Chalk Formation (Moorlock et al., 2003), which is equivalent to the Middle and Upper Chalk of the former classification (Forbes, 1965).

Cross section of the upper Cam valley

Figure 1a shows the line of a southwest-northeast geological cross section through the upper Cam valley running from Crossroad Cottages (TL 483428) through the M11 motorway, Ickleton village, the Genome Campus sites at Hinxton Riverside and Hinxton Hall, and terminating at the Stump Cross interchange on the A11 road (TL 504444).

The geological cross section (Fig. 2) shows two separate deeply buried 'tunnel valleys' incised into Chalk bedrock, with bases at c. 17 m OD, beneath the present upper Cam valley. The western channel-form, situated between the M11 motorway and Ickleton village is relatively narrow (c. 0.5 km wide), and filled by c. 11 m of glacio-lacustrine silt (Wicken Bonhunt Member) and c. 7 m of coarse 'glacial' gravel (Observatory Member), and is overlain by up to 2 m of sandy colluvial material. In contrast the eastern channel-form is considerably broader (c. 1.5 km), and at Ickleton village appears to be filled with up to 23 m of coarse gravel. The situation on the eastern flank of the valley near Stump Cross is somewhat complex, since it appears that the gravels here may represent both colluvial deposits and a series of terraces of the ancient River Cam system.

Neither of the channel-forms or their contained deposits are mapped by the BGS on Sheet 205 Saffron Walden (British Geological Survey, 2002), which instead shows 3rd and 2nd Terrace Deposits, and Holocene floodplain alluvium of the River Cam.

https://doi.org/10.1017/S0016774600000925 Published online by Cambridge University Press

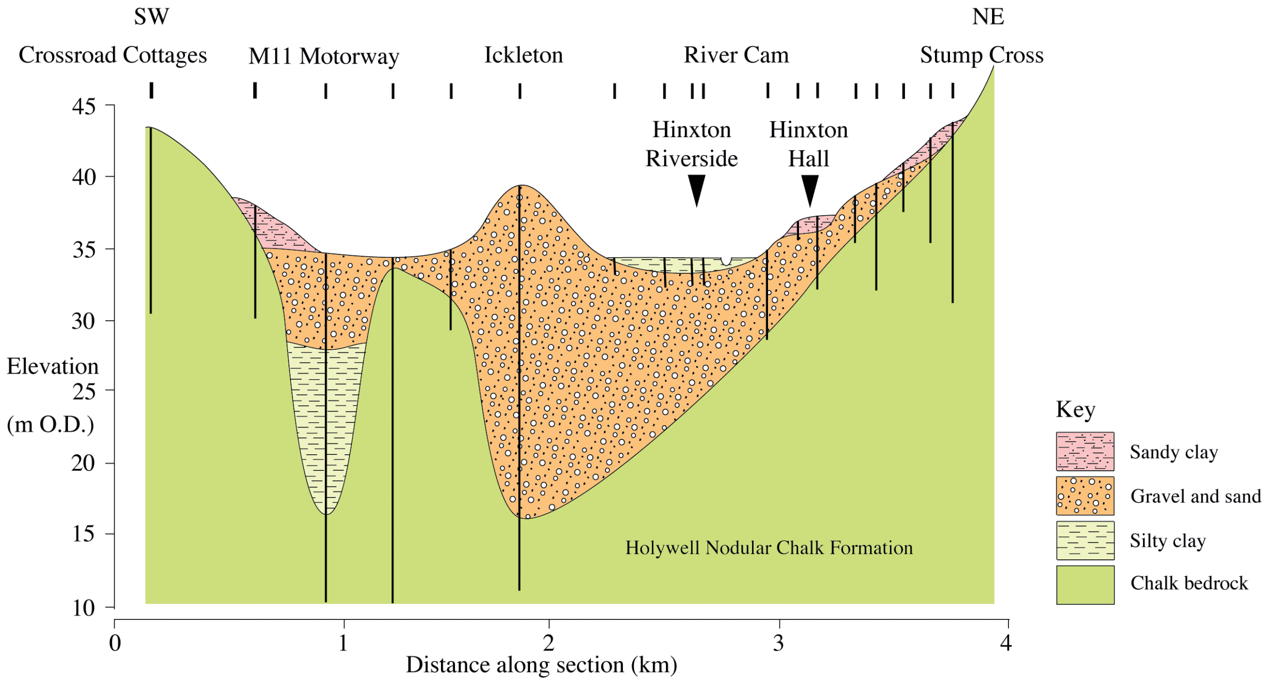

Fig. 2. Geological cross-section across the upper Cam valley constructed from borehole records.

However, the original Memoir for BGS Sheet 205 (White, 1932) clearly describes a 'buried glacial channel of the Cam valley' passing through the vicinity of Ickleton. This is also mentioned in a later brief explanation of Sheet 205 (Moorlock et al., 2003).

Hinxton Hall – Section I

Description

An area of gently sloping (1-2°) valley side east of a relatively flat presumed remnant of the 3rd Terrace surface had been cleared of c. 30 cm plough soil for archaeological inspection. The slope was generally underlain by up to 2 m of gravelly brecciated pellet chalk (lithofacies Dm), interpreted as a periglacial solifluction deposit. Similar re-worked chalky regolith material has been described from a variety of locations on Chalk hill slopes across the Cambridge Region (Boreham 2002). However, a number of conspicuous shallow channel-forms or runnels, 5-10 m across, aligned down-slope, and filled by brown and red-brown horizontally stratified medium sand (lithofacies Sh) were observed. A trench was excavated across one of the larger channels to inspect the stratigraphy of the slope deposits. Section I was described from the eastern face of the trench (Fig. 3).

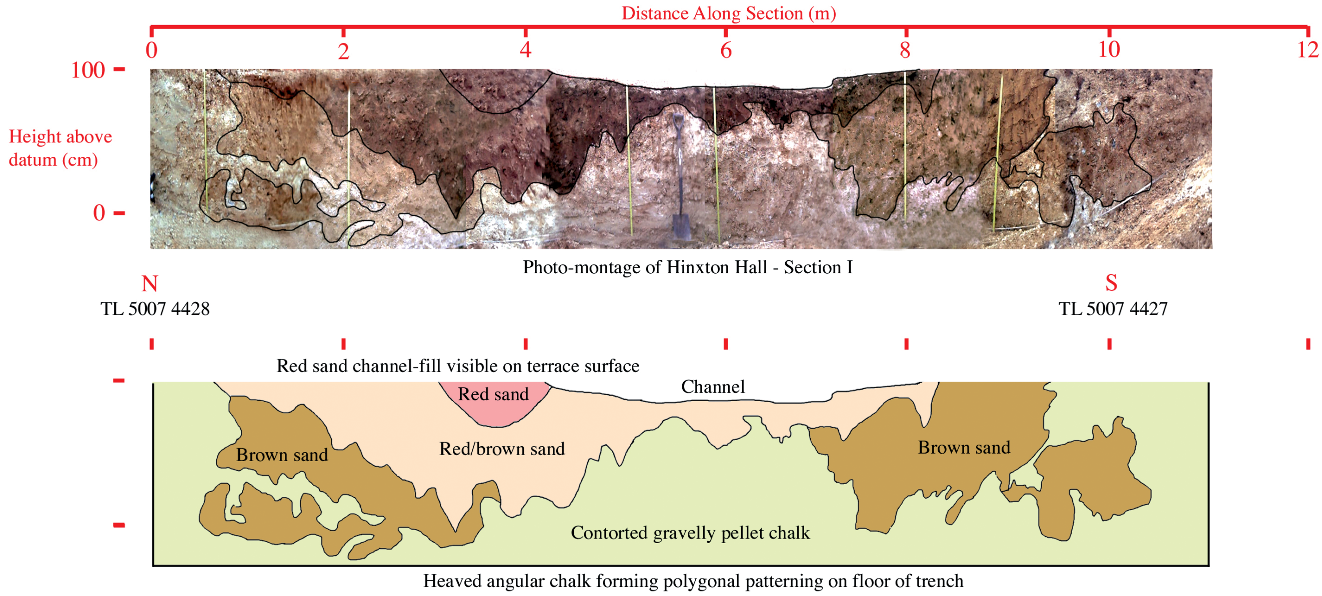

Fig. 3. Detailed stratigraphy of sediments at Hinxton Hall, Section I.

https://doi.org/10.1017/S0016774600000925 Published online by Cambridge University Press

The stratigraphy of Section I at 3.5 m was as follows:

Described bottom up	
125 to 155 cm	Plough soil (removed).
95 to 125 cm	Red medium (c. 500 μm) sand.
55 to 95 cm	Red/brown medium sand.
20 to 55 cm	Brown contorted medium sand.
0 to 20 cm	White/buff contorted gravelly brecciated pellet chalk.

There was strong evidence for periglacial activity on the floor of the trench where blocks of heaved angular and brecciated chalk formed polygonal patterning. The contorted gravelly brecciated pellet chalk is itself evidence for the mass movement of chalky regolith downslope under permafrost conditions (Murton, 1996). The brown sand unit overlying the brecciated pellet chalk clearly originated as decalcified slope wash, and must have been affected by periglacial activity, since it had been deformed by freeze-thaw action into tongues and diapirs within the chalky matrix. The potential sources of this sandy slope wash could be remnant fluvial deposits, glacial sediments or decalcified chalk. The overlying decalcified red/brown sand unit was much less disturbed and filled a small channel-form apparently incised into the underlying material by running water. The upper red sand unit formed the core of the channel feature, and occupied a small channel-form cut into underlying red/brown sand. The most recently active hillside channel appeared to be superimposed across the line of the older channel-forms.

Interpretation

These deposits are interpreted as representing Weichselian Late Pleniglacial or Late-glacial periglacial activity (brecciated pellet chalk diamict), climatic amelioration leading to slope wash (brown sand), followed by renewed periglacial activity, incorporating the brown sand unit into the chalky matrix. There was then a period of incision and the subsequent deposition of the colluvial red/brown sand unit, presumably during the early part of the Holocene. The heavily oxidised red sand unit may represent a time of temperate conditions prevailing before vegetation cover had fully stabilised soils on the valley side. The erosional channel cutting across the older deposits may date from later vegetation clearance in the catchment.

Hinxton Hall – Section II

Description

At the foot of the gently sloping valley side, on the flat terrace surface remnant some 80 m to the southwest of Section I, c. 30 cm of plough soil had been stripped away revealing a patch of red/brown shelly medium sand. A trench was excavated through this area to investigate the stratigraphy of the deposit. Section II was described from the northwest face of the trench (Fig. 4).

The stratigraphy of Section II at 7.0 m was as follows:

Described bottom up	
115 to 145 cm	Plough soil (removed).
95 to 115 cm	Red/brown medium sand with shells.
60 to 95 cm	Brown contorted medium (c. 500 μm) sand.
20 to 60 cm	White/buff contorted gravelly brecciated pellet chalk.
0 to 20 cm	Brown contorted medium gravel (c. 10 mm) and sand.
Below 0 cm	Obscured by talus.

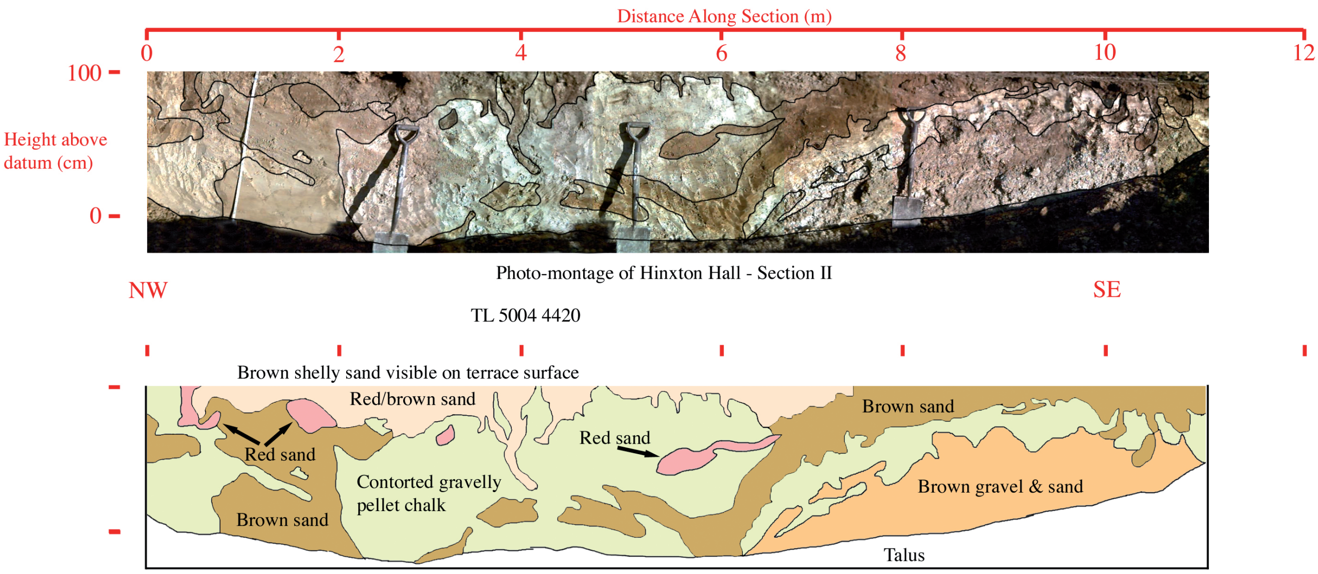

Fig. 4. Detailed stratigraphy of sediments at Hinxton Hall, Section II.

https://doi.org/10.1017/S0016774600000925 Published online by Cambridge University Press

The trench was floored by brown poorly-sorted matrix-supported gravel and sand (lithofacies Gh), which was overlain by contorted gravelly brecciated pellet chalk (lithofacies Dm). Strings, tongues and diapirs of brown sand were incorporated into this chalky matrix, indicating that periglacial activity must have re-started after the formation of these slopewash deposits. However, the overlying horizontally stratified red/brown shelly sand unit (lithofacies Sh) was generally less contorted, although it filled several pipes and fissures. The conspicuous mollusc shells were identified by R.C. Preece (Department of Zoology, University of Cambridge) as *Arianta arbustorum*, a large terrestrial snail intolerant of very cold conditions. No other mollusc taxa were found in this deposit.

Interpretation

These deposits are interpreted as representing a Pleistocene fluvial gravel terrace overlain by soliflucted Weichselian Late-glacial breciated pellet chalk, incorporating sandy material suggesting a short phase of slopewash, followed by renewed periglacial activity. It seems likely that the sandy deposits originally formed as a debris fan at the break in slope between the valley side and the gravel terrace, fed by runnels similar to that described in Section I. The upper red/brown sand unit with *Arianta* is probably early Holocene in age, and is clearly terrestrial slopewash rather than an aquatic deposit.

Hinxton Hall – Section III

Description

A trench excavated into the terrace surface some 20 m northwest of Section II provided a small northeast facing section showing contrasting stratigraphy;

The sequence at Section III was as follows:

Described bottom up	
170 to 205 cm	Plough soil (brown silty sand with pebbles).
85 to 170 cm	Light orange/brown slightly silty sand with occasional flint pebbles.
30 to 85 cm	Dark brown soft silty sand.
55 to 70 cm	Black silty sand with abundant charcoal.
50 to 55 cm	Grey sand with charcoal.
35 to 50 cm	Pale yellow slightly silty sand.
0 to 35 cm	Orange clayey sand, with carbonate mottling and *Chara* tubules. Charcoal staining at 15 and 25 cm.

It appeared that these deposits occupied a depression in the gravel terrace surface. The trench was floored by an orange clayey sand unit (lithofacies Fcf), containing the carbonate tubules of the freshwater alga *Chara*, which must have formed in a shallow pool or pond. The various horizontally stratified sand units (lithofacies Sh) overlying this appeared to be colluvial material derived from the adjacent valley side. A sample of charcoal was obtained from the black silty sand unit at 55-70 cm. This material was submitted to The University of Waikato, New Zealand, for radiocarbon dating. The uncalibrated date (Wk 13861) (4664 +/− 42 years BP) places the deposit in the mid-Neolithic (early Sub-Boreal period) (5300-5480 Calibrated calendar years BP 88.9%). This is interesting, since it implies that burning and clearance were taking place on the valley side and terrace surface at a relatively early date in the Holocene. This suggests that the underlying pond deposits (the orange clayey sand unit) date from earlier in the Holocene. It also implies that the overlying orange/brown silty sand unit (85-170 cm) may have formed as slope wash during the Bronze Age (late Sub-Boreal period) and Iron Age (early Sub-Atlantic period) (c. 4000-2000 calendar years BP), during times of extensive tree clearance. Unfortunately, pollen samples taken at 35cm and 65cm proved to be barren.

Interpretation

This sequence is interpreted as representing deposits of an early/middle Holocene, or possibly Late-glacial pool or pond on the terrace surface, which became in-filled by sandy slopewash. Charcoal in these sediments may represent episodes of local burning. It is clear that sandy slopewash continued to accumulate, recording burning events in the early Neolithic. The ongoing disturbance and clearance of vegetation on the valley side throughout the Bronze Age and Iron Age may have mobilised large quantities of colluvium, which appears to form the upper part of this sequence.

Hinxton Riverside – Section IV

Description

A 140 cm long sequence of alluvial sediments (lithofacies Fm) from the northeastern end of an archaeology trench on the floodplain of the River Cam at Hinxton Riverside was described and sampled for pollen.

The sequence at Section IV was as follows:

Described bottom up	
110 to 132 cm	Grey silty clay (plough soil).
101 to 110 cm	Grey silty clay, darker horizon with pebbles.
80 to 101 cm	Orange/grey mottled silty clay, occasional molluscs.
60 to 80 cm	Brown mottled silt, some sand and charcoal.
49 to 60 cm	Brown sandy silt, mottling at 40 cm, occasional molluscs.
32 to 49 cm	Grey/green organic sandy silt, with molluscs.
26 to 32 cm	Grey/black clay, less organic towards top.
12 to 26 cm	Black organic clay.
0 to 12 cm	Grey/brown silt with organic fragments.
Below 0 cm	Coarse grey flint gravel.

https://doi.org/10.1017/S0016774600000925 Published online by Cambridge University Press

Pollen analysis

Eight samples from this sequence were taken for pollen analysis. Pollen preparation, counting and identification were as described by Bennett (1983). Plant taxonomy follows Stace (1991), and incorporates the suggestions of Bennett et al. (1994). Where possible, a minimum of 300 land-pollen and spores was counted at each level.

In general, the pollen sequence from Section IV (Fig. 5) is typical of the Holocene vegetational succession from southern England, recording the rise of pine, hazel and mixed-oak woodland, followed by a decline in trees.

The grey/brown silt with organic fragments from the basal part of the sequence (5 cm) was characterised by high frequencies (c. 20%) of willow (*Salix*), with pine (*Pinus*), birch (*Betula*), hazel (*Corylus*), grass (Poaceae) and fern spores (Pteropsida). This is interpreted as an early Holocene (Boreal) assemblage, representing local wet woodland (carr) with scattered hazel and birch scrub and stands of boreal woodland, in an otherwise open grassland environment. The pollen of sedges (Cyperaceae) and bur-reed (*Sparganium*) suggests that emergent marginal vegetation grew close by.

The black organic clay (15 cm) contained abundant pine pollen (c. 40%) with subordinate birch, hazel, willow and grass. This is interpreted as representing the expansion of boreal woodland at the beginning of the Holocene, c. 9500 calendar years BP.

In contrast, the pollen signal from the top of the black organic clay and overlying sandy silt (25 cm, 35 cm, 45 cm, 55 cm) records the rise of temperate arboreal taxa such as oak (*Quercus*), elm (*Ulmus*) and lime (*Tilia*). Pollen of alder (*Alnus*) and hazel is also important, and is accompanied by rising curves for grass, sedge and herbs. This is interpreted as the rise of mixed-oak woodland in the catchment and the development of alder carr on the river floodplain. The time interval represented by this part of the sequence appears to be between c. 8500 (Mesolithic - late Boreal) and c. 3000 calendar years BP (late Bronze Age - late Sub-Boreal), although the pollen concentration becomes poor in the uppermost samples making the signal less reliable.

The mottled brown silt with charcoal (65 cm) contained a pollen spectrum dominated by grass, with willow, sedge and herbs. This clearly represents a time of woodland clearance. However, pollen types indicating soil disturbance (for example *Plantago lanceolata*) and arable activity (cereals) were not found, suggesting that farming was not an important landscape activity here in the Bronze Age. The pollen sample from the top of the brown silt unit (75 cm) had a very low pollen concentration and was dominated by pollen of Asteraceae (Lactuceae). The super-abundance of these resistant pollen types together with Pteropsid spores is often taken as evidence for post-depositional differential oxidation of pollen, usually through soil processes.

Interpretation

This alluvial sequence is interpreted as representing much of the early and middle Holocene (Boreal and Atlantic periods), apparently terminating with tree clearance within the Bronze Age (late Sub-Boreal period). The lower part of the sequence is dominated by organic sediments that grade upwards into inorganic alluvium. Holocene alluvial sequences from the lower Cam valley also exhibit this pattern of sedimentation (Boreham, 2002). The basal flint gravel deposit is presumably of Weichselian Late-glacial age. As elsewhere in the Cam system, the present river course appears to have been inherited from a Late-glacial incisional event, and has apparently remained relatively stable throughout the Holocene (Boreham 2002, cf Gibbard and Lewin

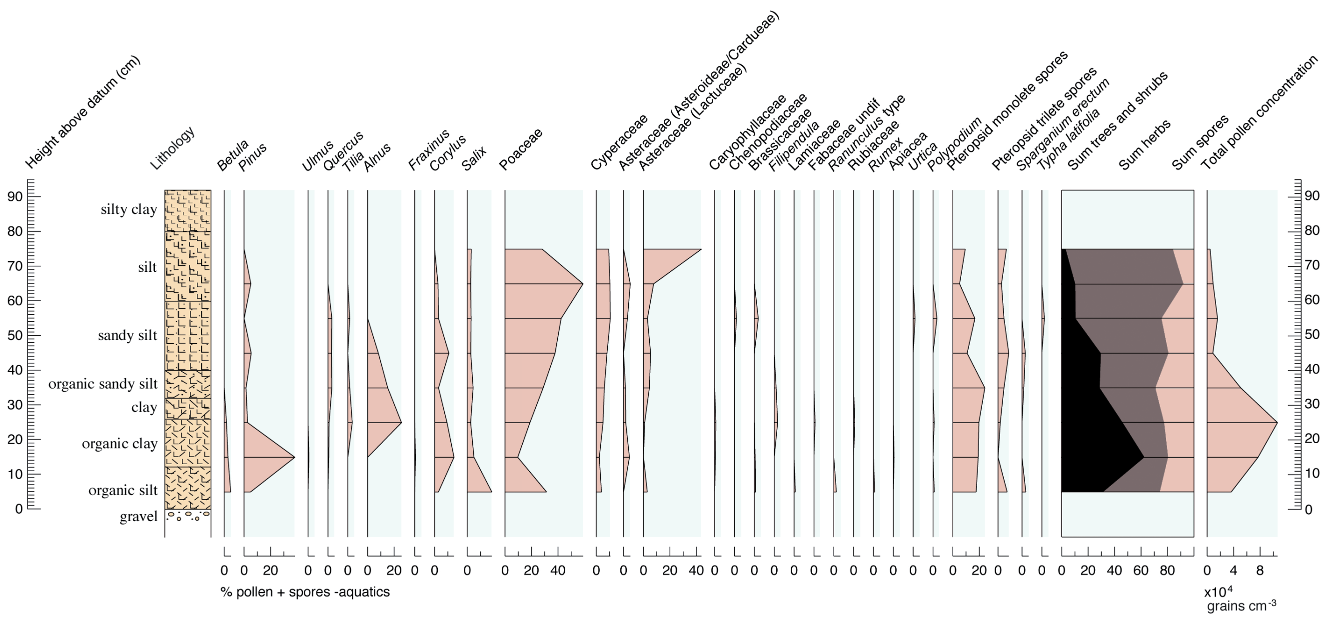

Fig. 5. Skeletal percentage pollen diagram from Hinxton Riverside, Section IV.

https://doi.org/10.1017/S0016774600000925 Published online by Cambridge University Press

2002). At several localities on the floodplain, coarse gravels containing abundant exotic lithologies, and cobbles up to 300 mm diameter were observed directly underlying the Holocene alluvium. This material is unlikely to have been transported very far by the River Cam in the Weichselian, and is interpreted as representing the coarse glacial gravel filling the eastern 'tunnel valley' channel-form (Fig. 2). It is possible that the presence of such resistant material on the floor of the valley caused the River Cam to adopt a meandering course around the outcrops of coarse-grade glacial gravel, which itself may have been re-worked during the Weichselian Late-glacial (cf Baker 1977).

Hinxton Riverside – Section V

Description

A 105 cm long sequence of pond and alluvial sediments (lithofacies Fm) from the southwestern end of the archaeology trench (25 m from Section IV) on the floodplain of the River Cam at Hinxton Riverside showed the following stratigraphy;

The sequence at Section V was as follows:

Described bottom up	
75 to 105 cm	Ploughsoil removed.
56 to 75 cm	Grey/brown mottled silty clay with molluscs.
32 to 56 cm	Grey silty clay with organic flecks and molluscs.
28 to 32 cm	Orange mottled silty clay.
23 to 28 cm	Grey silt with organic flecks and abundant molluscs.
15 to 23 cm	Black organic silt with wood and occasional molluscs.
10 to 15 cm	Black organic silt with worked wood and pebbles.
0 to 10 cm	Grey/yellow medium gravel and coarse sand.
	The upper surface formed into a cobbled 'pavement'.

Section V showed a basal flint pebble 'pavement' overlain by a black organic silt unit, which contained wood fragments and a woven wooden hurdle, overlain in turn by an alluvial silty clay. Worked wood obtained from the black organic silt unit (10-15 cm) was identified as ash (*Fraxinus*) by W.J. Fletcher (Department of Geography, University of Cambridge). This material was submitted to The University of Waikato, New Zealand, for radiocarbon dating. The uncalibrated date (Wk 11634) (1143 +/– 51 years BP) places the wood and presumably the organic silt and possibly the flint pavement in the Saxon period (1180-950 Calibrated calendar years BP 95.0%), which would make the overlying alluvial silty clay Medieval or later.

Interpretation

There is an immediate difficulty with correlation, in that the alluvial sequence at Section IV apparently represents the early and middle Holocene, terminating in the Bronze Age (c. 3000 calendar years BP), yet the base of the alluvial sequence at Section V appears to be Saxon (c. 1200 calendar years BP). An obvious conclusion would be that a Saxon channel must be cut into the older sediments, leading to the apparent juxtaposition of superficially similar sequences of different ages. However, detailed inspection of the stratigraphy of the archaeology trench between Sections IV & V revealed little evidence for a discrete channel-form. Nevertheless it seems likely that a shallow chute 'channel', possibly anthropogenic in origin, crossing the meander bend and occupied by the river in times of flood created an on-stepping alluvial floodplain sequence in which the sediments were deposited progressively further away from the older sediments closer to the river. This phenomenon is not uncommon in fluvial sequences, and can be best understood as the lateral diachronous migration of different depositional environments across the floodplain (Walker & Cant, 1984).

At the time of the Saxon activity, the sediments at Section IV may have formed a natural bank or levee. It appears that a 'pit' or pool was constructed in the basal flint gravel, which was surrounded by an artificial gravel 'pavement'. Large worked wooden posts and the wooden hurdle were emplaced, possibly as part of a system of fish ponds.

Discussion and Conclusions

Taken together, the evidence from Hinxton Hall records Late-glacial periglacial activity, a phase of slopewash and then renewed periglacial action, perhaps during the Loch Lomond Stadial (11.5-13 k calendar years BP). In the early Holocene, a series of valley side runnels (Section I) developed delivering sandy colluvial material to debris fans (Section II) and pond-like areas (Section III) on the terrace surface (Fig. 6). It is likely that as woodland vegetation became established on the valley side, and soils stabilised, the amount of colluvial sediment reduced significantly. However, there is direct evidence for Neolithic burning and a suggestion that valley side runnels became re-established in the Bronze Age/Iron Age delivering new colluvial material onto the terrace surface. In many respects, this sequence of events mirrors those described by Preece & Bridgland (1999) from Late-glacial chalky slope deposits at Holywell Coombe, Kent, UK.

At Hinxton Riverside, the River Cam appears to occupy a course inherited from Weichselian Late-glacial incision. Inheritance of Late-glacial channels by early Holocene rivers has been repeatedly observed in the River Cam system (Boreham, 2002), and elsewhere in lowland Britain (Brown et al., 1994; and Gibbard, 1985, 1989). In contrast, in neighbouring parts of continental Europe, incision is seen at the transition from the Late-glacial to the Holocene (Vandenberghe, 1993; Antoine et al., 2007).

The pollen sequence from Section IV represents much of the early and middle Holocene, apparently terminating with tree

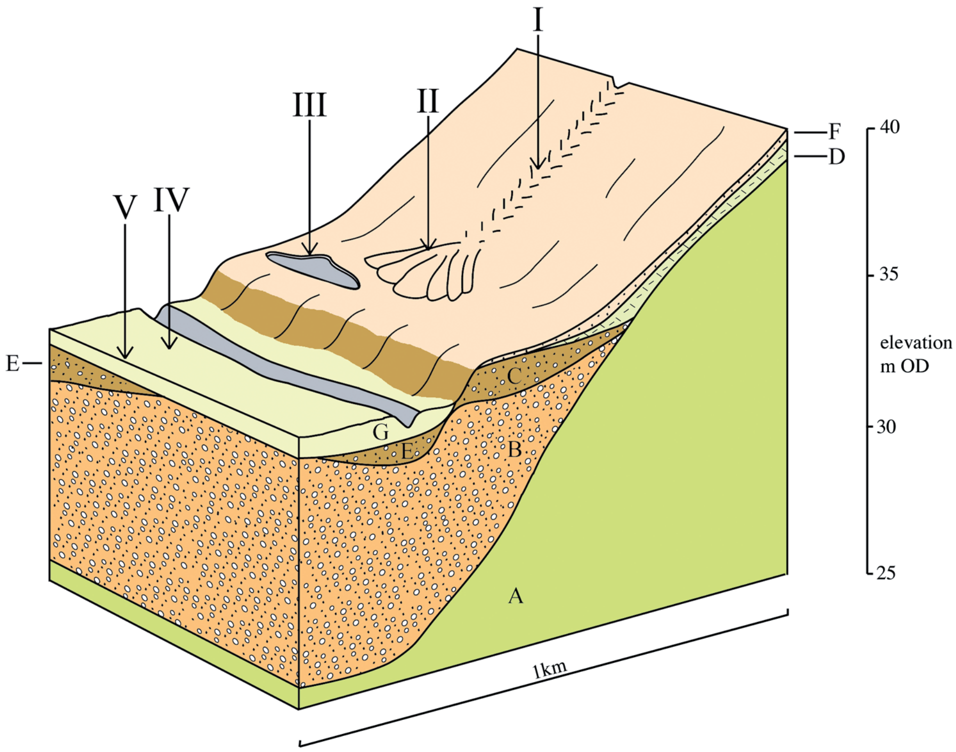

Fig. 6. Block diagram showing the location of Sections I-V, and the landforms and stratigraphy of sediments in the upper Cam valley at Hinxton Genome Campus. See Discussion and Conclusions for further explanation.

Key
A - Bedrock of the Holywell Nodular Chalk Formation
B - Coarse-grade glacial gravel (Observatory Member – Lowestoft Formation) filling a buried 'tunnel valley'
C - Gravel river terrace (Bordeaux Pit Member – Cam Valley Formation) of probable Middle Pleistocene age
D - Soliflucted brecciated pellet Chalk diamict probably dating from the Late Glacial
E - Weichselian river gravels
F - Early Holocene sandy colluvial deposits
G - On-stepping Holocene alluvial sequence belonging to the Fenland Formation

clearance in the Bronze Age. Increased fluvial sediment load from this deforestation may have initiated flooding and the formation of chute cut-offs across meander loops on the flood-plain. The radiocarbon date from Section V indicates human activity on the river floodplain during Saxon times, followed by the accumulation of overbank alluvial sediments during the Medieval period. It seems likely that the on-stepping alluvial sequence here encompasses deposition throughout the later part of the Holocene.

The block diagram in Fig. 6 summarises the landforms and stratigraphy of the upper Cam valley at Hinxton Genome Campus. Bedrock of the Holywell Nodular Chalk Formation (A) underlies the area. Coarse-grade glacial gravel with erratics (Observatory Member – Lowestoft Formation) of presumed Elsterian age (B) fills a 'tunnel valley' channel-form incised in to the Chalk. A gravel river terrace (Bordeaux Pit Member – Cam Valley Formation) of probable Middle Pleistocene age (C) overlies the glacial gravel and is present on the valley side. This is overlain by the soliflucted brecciated pellet Chalk diamict (D) probably dating from the Late-glacial, and by early Holocene sandy colluvial deposits (F). On the valley floor, Weichselian river gravels (E) are overlain by an on-stepping Holocene alluvial sequence belonging to the Fenland Formation (G).

This new geological model represents a refinement of the known configuration of terrace deposits in the upper Cam valley, and allows a better understanding of Late-glacial and Holocene slope processes. It seems likely that this model is applicable to much of the upper Cam system. However, neigh-bouring river systems such as the Rhee and Granta do not appear to be aligned with buried Elsterian 'tunnel valleys' like the River Cam, and so may not conform to this pattern.

Acknowledgements

The authors would like to thank the Cambridgeshire County Council Archaeological Field Unit (now Oxford Archaeology East) for access to the Hinxton Genome Campus site. Thanks to Dr W. J. Fletcher for identifying wood and to Dr R.C. Preece for confirming identification of the molluscs. The authors would also like to thank Prof. P.L. Gibbard, Dr S. Lewis, Mr. P. Kiden & Prof. P. Antoine for their helpful comments on the manuscript.

References

Antoine, P., Lozouet, N.L., Chaussé, C., Lautridou, J-P., Pastre, J-F., Auguste, P., Bahain, J-J., Falguères, C. & Galehb, B., 2007. Pleistocene fluvial terraces from northern France (Seine, Yonne, Somme): synthesis, and new results from interglacial deposits. Quaternary Science Reviews 26, 2701-2723.

Baker, C.A., 1977. Quaternary stratigraphy and environments in the upper Cam valley. Ph.D. thesis, University of London.

Bennett, K.D., 1983. Weichselian late-glacial and Flandrian vegetational history at Hockham Mere, Norfolk, England. I. Pollen percentages and concentrations. New Phytologist 95: 457-487.

Bennett, K.D., Whittington, G. & Edwards K.J., 1994. Recent plant nomenclatural changes and pollen morphology in the British Isles. Quaternary Newsletter, 73: 1-6.

Brown, A.G., Koegh, M.K. & Rice, R.J., 1994. Floodplain evolution in the East Midlands, United Kingdom: the Lateglacial and Flandrian alluvial record from the soar and Nene valleys. Philosophical Transactions of the Royal Society of London A, 348: 261-293.

Boreham, S., 2002. The Pleistocene Stratigraphy and Palaeoenvironments of the Cambridge District. PhD thesis. Open University.

Bowen, D.Q. (ed.), 1999. A revised correlation of Quaternary deposits in the British Isles. Geological Society Special Report No. 23, Geological Society of London: 174 pp.

British Geological Survey, 2002. Saffron Walden. England and Wales Sheet 205 Solid and Drift Geology. 1 : 50 000. British Geological Survey, Keyworth, Nottingham.

Forbes, C.L., 1965. Geology and Groundwater. In: Steers, J. A. (Ed) The Cambridge Region 1965. British Association for the Advancement of Science, London.

Gibbard, P.L., 1985. Pleistocene history of the Middle Thames Valley. University Press: Cambridge: 155 pp.

Gibbard, P.L., 1989. The Geomorphology of a part of the Middle Thames: forty years on. A reappraisal of the work of F. Kenneth Hare. Proceedings of the Geologists' Association 100: 481-503.

Gibbard P.L, & Lewin J., 2002. Climate and related controls on interglacial fluvial sedimentation in lowland Britain. Sedimentary Geology 151: 187-210.

Lambert, C.A., Pearson, R.G. & Sparks, B.W., 1962. A flora and fauna from late Pleistocene deposits at Sidgwick Avenue, Cambridge. Proc. Linn. Soc. London. 174: 13-30.

Marr, J.E., 1926. The Pleistocene deposits of the lower part of the Great Ouse basin. Quarterly Journal of the Geological Society, 82: 101-143.

Miall, A.D., 1977. A review of the braided river depositional environment. Earth Science Reviews 13: 1-62.

Miall, A.D., 1985. Architectural-element analysis: A new method of facies analysis applied to fluvial deposits. Earth Science Reviews 22: 261-308.

Moorlock, B.S.P., Boreham, S., Woods M.A. & Sumbler, M.G., 2003. Geology of the Saffron Walden district – a brief explanation of the geological map. Sheet explanation of the British Geological Survey. 1 : 50 000 Sheet 205 Saffron Walden (England and Wales).

Murton, J.B., 1996. Near-Surface Brecciation of Chalk, Isle of Thanet, South-East England: a comparison with Ice-rich Brecciated Bedrocks in Canada and Spitzbergen. Permafrost and Periglacial Processes 7: 153-164

Preece, R.C. & Bridgland, D.R., 1999. Holywell Coombe, Folkestone: A 13,000 year history of an English Chalkland Valley. Quaternary Science Reviews 18: 1075-1125.

Sparks, B.W., 1955. Notes on four Quaternary deposits in the Cambridge region. Journal of Conchology 24: 47-53.

Stace, C., 1991. New flora of the British Isles. Cambridge University Press (Cambridge): 1250 pp.

Vandenberghe, J., 1993. Changing fluvial processes under changing periglacial conditions. Zeitschrift für Geomorphologie (Supplement), 88, 17-28.

Walker, R.G. & Cant D.J., 1984. Sandy Fluvial Systems. *In:* Walker R.G. (ed.): Facies Models. Geological Association of Canada.

White, H.J.O., 1932. The geology of the country near Saffron Walden. Memoir of the Geological Survey. HMSO.

https://doi.org/10.1017/S0016774600000925 Published online by Cambridge University Press