THAMES VALLEY ARCHAEOLOGICAL SERVICES

Former Highbury and Fisherton Manor Schools, Highbury Avenue, Salisbury, Wiltshire

Quaternary Geology Test Pit

by Steve Ford

Site Code: HSS13/101

(SU 1327 3065)

Former Highbury and Fisherton Manor Schools, Highbury Avenue, Salisbury, Wiltshire

Excavation of a Quaternary Geology Test Pit

for Taylor Wimpey Southern Counties

by Steve Ford

Thames Valley Archaeological Services Ltd

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Summary

Site name: Former Highbury and Fisherton Manor Schools, Highbury Avenue, Salisbury, Wiltshire

Grid reference: SU 13289 30575

Site activity: Quaternary Geology Test Pit

Project manager: Steve Ford

Site supervisor: Steve Ford

Site code: HSS 13/101

Summary of results: The test pit examined a 4.4m thickness of brickearth deposits overlying gravel. The upper brickearth levels had been redeposited but the lower levels were largely *in situ* and seemed to lie in an area of floodplain perhaps in a marshland environment and subject to inundation. No archaeological deposits nor artefacts were recovered. Two Optically Stimulated Luminescence dates from the *in-situ* brickearth levels returned dates of 47±8 Ka BP and 56±9 Ka BP.

Report edited/checked by:	Steve Preston✓ 24.03.14

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Report 13/101

Introduction

The project described below is a component part of an archaeological excavation at the former Highbury and Fisherton Manor Schools, Highbury Avenue, Salisbury, Wiltshire (SU 1327 3065) (Fig. 1). Planning permission (S/2012/1282) has been gained from Salisbury District Council to construct housing on the former school site. The consent is subject to a condition (5) relating to archaeology as guided by the *National Planning Policy Framework* (NPPF 2012). The work was commissioned by Mr Saul Mead of Taylor Wimpey Southern Counties, Templars House, Lulworth Close, Chandlers Ford, Easstleigh, Hampshire, SO53 3TJ.

This component of the project followed on from an excavation of Iron Age deposits located at the northern end of the site. This fieldwork took place between the 18th and 24th July 2013 by Steve Ford and Aidan Colyer and the site code is HSS 13/101. The archive is currently held by Thames Valley Archaeological Services, 47-49 De Beauvoir Road, Reading, RG1 5NR and will be deposited Salisbury Museum in due course.

Topography and geology

The whole site comprises a rectangular parcel of land on ground that sloped steeply down before levelling out slightly to the south, reflecting the formation of the northern side of the valley of the River Nadder. The site slopes from *c*.70m above Ordnance Datum down to 57m. The underlying geology reflects the topography with upper chalk outcropping at the top (north) with varying deposits of coombe rock, gravel and brickearth to the south (BGS 1976) (Fig. 2). The test pit site (SU 13289 30575) lies on Pleistocene sand and gravels overlying chalk. These are 4th terrace deposits with undifferentiated deposits to the north. Brickearth and coombe rock overlie these gravel deposits. The terraces represent fluvial deposition by the proto-Avon after 250,000 years BP (250Ka BP) and at least 15 terraces have been identified for the Lower Avon Valley in general.

Construction of the school in the 1930s had necessitated the formation of artificial terraces with large areas of cut and fill present. On the southern parts of the site, several areas of former brickearth pits were present. The test pit was located towards the southern margins of the overall site where previous investigations had indicated that, despite the brick pits, the greatest thickness of brickearth was to be found.

Archaeological background

The archaeological potential of the site as a whole has been identified by field evaluation (CA 2010; WA 2012) and summarized in a desk-based assessment (CgMs 2012). In summary evaluation trenching has revealed the survival of Iron Age features which were suspected from aerial photographs of the site taken before the school buildings were constructed and from earlier finds during brickearth extraction to the north (Stevens 1934). The site also lies in a general area from which Palaeolithic remains have been recorded during extraction of brick-earth. Despite some extraction, evaluation has shown the survival of areas of brickearth on the site (WA 2012).

The formation of the river terraces of the River Avon took place in the Pleistocene at a time when there was Lower and Middle Palaeolithic occupation of Britain and there are a number of findspots of flint tools recorded from the general environs of the site, as detailed in the desk-based assessment (CgMs 2012). Lower Palaeolithic remains have been encountered in all the higher fluvial terraces of the Avon, with a dense cluster of findspots near Salisbury at the confluence of the Wylye, Avon and Bourne (Wymer 1999, fig. 29). An Upper Palaeolithic site has been excavated at Nea Farm, Somerley (Hampshire), located on the top of a brickearth deposit (Barton *et al*. 2009). Palaeoenvironmental material (e.g. bone or pollen assemblages) is extremely rare in the Avon Valley in the Middle Pleistocene gravel deposits but the brickearth deposits within the environs of the site have produced some faunal and molluscan assemblages (CgMs 2012). The dating of the terrace sequence is not yet clear and it may often be difficult or impossible to correlate terrace remnants as belonging to a single geological phase, even when they lie in quite close proximity. The Palaeolithic period is generally poorly understood (Hosfield 2007).

Aims and objectives of the test pit

The project was drawn up as guided by paragraph 6.5 of the mitigation strategy outlined in the desk-based assessment for the site (CgMs 2012). Research aims were to:

assess the potential of the surviving Brickearth to contain Pleistocene palaeoenvironmental evidence and Palaeolithic material;

characterize the formation processes involved in the deposition of the brickearth;

record the interfaces of the brickearth with the Coombe Rock, Terrace Gravels (Higher or Lower) and Chalk bedrock, especially at the ‘feather edge’.;

compile a full sectional sequence of the Quaternary deposits across the axis of the valley side (i.e. north-south);

sample the Brickearth for Pleistocene fauna, microfauna and molluscan evidence if present; and

assess the potential for using appropriate dating techniques for the deposit sequence.

The Test Pit

The test pit had nominal dimensions of 10m x 10m at the top so as to provide safe access at a depth of up to 5m. It was anticipated that this would provide a full exposure of the brickearth deposits above gravel as estimated from the geotechnical borehole logs taken for the development. The pit was to be stepped in nominal 1m units.

The brickearth was to be removed by a machine fitted with a toothless bucket and be excavated in 0.1m spits and/or to any stratigraphic horizons. A sample of 100L of soil from each spit was to be dry sieved using a 10mm mesh for the recovery of any artefacts.

Any post-glacial archaeological deposits at the surface of the brickearth were to be excavated and recorded prior to the bulk removal of the brickearth. If any *in-situ* Palaeolithic deposits or artefact scatters were encountered, the digging of the test pit was to cease.

Results

The test pit was dug with surface dimensions of *c* .10m x 8m and with steps of *c*. 1–1.3m (Figs 2 and 3). Much of the upper 2m of the sequence had been disturbed by brickearth extraction pits which were markedly square in section and had been backfilled with soil including with 19th- and 20th-century objects. For the undisturbed brickearth, very few stones were recorded and this facilitated their close inspection for any humanly worked material. Despite this, no lithic artefacts were revealed. Similarly the sieving revealed no lithic artefacts nor any faunal remains.

The detailed stratigraphic description and interpretation was carried out by Dr Simon Colcutt of Oxford Archaeological Associates and is presented in full as Appendix 1.

Optically Stimulated Luminescence Dating

Two samples for Optically Stimulated Luminescence dating were taken following Dr Colcutt's assessment and sent to Dr Phillip Toms at the University of Gloucestershire Luminescence Dating Laboratory. His report is presented in full as Appendix 2. The two samples were taken from the mid to lower levels of the formation and specifically targeted thin sand lens within the brickearth indicative of an episode of gentle flowing water. Sample 1 was taken at a depth of 2.55m (54.78m aOD) (Fig. 3; Appendix 1, fig 7c) and returned a date of 47$\pm$8 Ka BP. Sample 2 was taken at a depth of 3.58m (53.64m aOD) and returned a date of 56$\pm$9 Ka BP.

Conclusion

The test pit successfully examined a 4.4m deep sequence of brickearth deposits which overlay the gravel of terrace 4. Detailed analysis revealed that the upper brickearth levels to a depth of *c*. 2m were without structure indicating that they had been redeposited as mass movement episodes from higher up the slope. Their archaeological potential is minimal. However, the lower levels were laminated with fine lenses of sand and some evidence of biological activity suggesting they were largely *in situ* and laid down in still or slow flowing water but were episodically exposed as land. These levels originally comprised floodplain deposits perhaps in an environment of marshland. Two OSL dates of 47±8 Ka BP and 56±9 Ka BP provide absolute dates for part of the formation sequence and correspond with the earlier part of MIS stage 3. This long period was generally an interstadial element of the conventional Devensian period and the Middle Palaeolithic.

Such a wet location is unlikely to have been chosen for human habitation but may well have been one for exploitation. However, no archaeological deposits nor artefacts nor faunal remains were recovered.

References

Barton, N, Ford, S, Collcutt, S, Crowther, J, Macphail, R, Rhodes, E and Van Gijn, A, 2009, 'A Final Upper Palaeolithic site at Nea Farm, Somerley, Hampshire and some reflections on the occupation of Britain in the Late Glacial Interstadial', *Quartär,* **56**, 7–35

BGS, 1976, *British Geological Survey*, 1:50000, Sheet 298, Solid and Drift Edition, Keyworth

CA, 2010, 'Highbury School, Salisbury, Wiltshire, archaeological evaluation', Cotswold Archaeology client report 10105, Cirencester

CgMs, 2012, 'Former Highbury and Fisherton Manor Schools, Salisbury, Wiltshire, desk-based assessment', CgMs consulting report 13469, London

Hosfield, R, 2007, 'Palaeolithic and Mesolithic' in (ed) C J Webster, *The Archaeology of South West England: South West Archaeological Research Framework Resource Assessment and Research Agenda*, Taunton, 23–62

NPPF, 2012, *National Planning Policy Framework*, Dept Communities and Local Government, London (TSO)

Stevens, F, 1934, 'The Highfield Pit Dwellings, Fisherton, Salisbury, excavated May 1866 to September 1869', *Wilts Archaeol Natur Hist Mag* **46**, 579–624

WA, 2012, 'Former Highbury and Fisherton Manor Schools, Salisbury, Wiltshire, Palaeolithic test pit evaluation report', Wessex Archaeology report 83780.03, Salisbury

Webster, C J (ed) 2007, *The Archaeology of South West England: South West Archaeological Research Framework Resource Assessment and Research Agenda*, Taunton,

Wymer, J J, 1999, *The Lower Palaeolithic Occupation of Britain,* Salisbury

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PLEISTOCENE ISSUES

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1. Introduction

1.1 On the 22nd. July, 2013, Dr. S. Ford (Thames Valley Archaeological Services Limited) commissioned Oxford archaeological Associates Limited to provide technical support on Pleistocene issues arising at a housing development site (the former Highbury & Fisherton Manor Schools, centred at SU 1327 3065) on Highbury Avenue, Salisbury. Accordingly, on the 30th. July, Dr. S.N. Collcutt (OAA) attended the site.

1.2 A large trial pit had been cut under the supervision of TVAS in approximately the location shown on Fig.1 (see main report for exact location). The pit had stepped sides (approximately 1 m vertically for each step), such that safe and close access could be gained to all parts of the sequence, although, necessarily, the area of exposure decreased with depth. The main description was conducted using the faces in the northern side of the pit, although supporting observations were also made on the west face and on faces along the access ramp on the northeast side.

2. Background

2.1 A recent desk-based assessment [1] has the following relevant details concerning the physical context of the site:

> *3.1* ***Geology***
> *3.1.1 The underlying bedrock geology of the area is mapped as Newhaven chalk Member of the Cretaceous Period (BGS 2005). Superficial deposits are mapped as River Terrace Deposits (formerly Brickearth) with undifferentiated Terrace Deposits upslope to the north and Fourth River Terrace deposits down slope to the south. Much of the site is also shown as Infilled Ground (Infilled former quarry workings).*
>
> *3.2* ***Topography***
> *3.2.1 Topographically the site varies between 58m AOD in the south and 69m AOD in the north.*

2.2 In respect of the Pleistocene and Palaeolithic interest, the assessment continues as follows:

> *4.2.1 The site is believed to be in, or close to, the former locations of Hardings Pit and Fulchers Pit, which as two of the Fisherton Brickpits produced Palaeolithic implements and associated faunal remains in the 19th Century, (Fig. 2). The pits produced three hand axes and two waste flakes dating to the period (MWI11087). The adjacent pit (identified on Fig. 2 as pit 'A') contained at least mammoth and rhinoceros remains. The extraction of Brickearth at the site is previously thought to have all but exhausted Brickearth deposits in the site area (Delair and Shackely 1978)* [2].
>
> *4.2.2 The recent archaeological evaluation at the site (Cotswold Archaeology 2010) revealed that Brickearth deposits are still present at the site, primarily in the south, identified within Trenches 1, 2 and 4 (Fig. 3) (Appendix 2).*

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[1] SMITH, M. & BOURN, R. 2012. *The Former Highbury and Fisherton Manor Schools, Highbury Avenue, Salisbury, Wiltshire – A desk-based assessment* Report by CgMs Consulting (Report 13469) for Taylor Wimpey Southern Counties (June 2012).

[2] Actually: DELAIR, J B & SHACKLEY, M L. 1979. The Fisherton Brickpits; their stratigraphy and fossil contents. *Wiltshire Archaeological & Natural History Magazine* 72:3-16.

Brickearth investigated within Trench 1 contained an unidentified mineralised bone and produced small quantities of charcoal fragments and molluscs.

4.2.3 The second phase of evaluation [by Wessex Archaeology] *comprises the excavation of five test pits in the (lower) southernmost part of the site to establish the extent of surviving Pleistocene brickearth indicated from earlier site investigations (Appendix 3). These revealed that though heavily impacted upon by post-medieval quarrying, the natural brickearth deposits survive at a relatively shallow depth (0.22m) in the southern part of the site. The western extent of this lower area comprises a backfilled 19th century quarry pit, yet brickearth is still present at 2.91m below ground level. Earlier associated geotechnical information indicates this is up to c. 3.50m thick in this area. The earlier evaluation and geotechnical work has established that brickearth is also preserved in the south-eastern extent of the northern part of the site (though to a lesser degree). The geotechnical data also indicates the potential for an important geological interface between the brickearth and Terrace Gravels or Chalk bedrock in this area.*

4.2.4 Outside of the site to the north various handaxes and retouched flakes have been discovered in the vicinity of the Highfield Pits and Fisherton Waterworks (MWI11078). Seventy two handaxes are recorded as being discovered 500m to the west of the site from a former gravel quarry referred to as 'Bemerton' (MWI11080). Also 500m to the west of the site, a single handaxe has been discovered in the garden of 32 New Zealand Avenue (MWI11086). To the south-west of the site at Cherry Orchard Lane a handaxe was found associated with mammoth remains in the area of the former Reade's Pit 500m away (MWI11082).

4.2.5 Based on current evidence that Brickearth remains are still present at the site the potential for further Palaeolithic artefactual and Palaeo-environmental remains is considered as high.

[...]

5.1.3 The industrial extraction of Brickearth does not appear to have extended in to the northern third of the site. Here the archaeological evaluation found a buried soil covering Coombe Rock deposits which in turn overlays the Brickearth. [...]

5.1.4 In the south of the site the recent evaluation discovered that the Coombe Rock has clearly been removed to facilitate the extraction of Brickearth in this area. The Brickearth was discovered at between 1.1m and 1.4m below modern ground level overlain by infill and modern formation deposits. It is within the remaining Brickearth that nationally significant Palaeolithic remains could potentially occur.

2.3 The full reports/appendices referred to above are not reproduced here. However, the 2012 evaluation by Wessex Archaeology (Report 83780.03 reproduced as CgMs Appendix 3) specifically targeted at the Pleistocene issues recorded the following details:

Brickearth

*5.2.1 Brickearth was recorded in all test pits; surviving at depths of only 0.20 – 0.30m below ground level (c. 57.40m aOD) in the mid-east of the evaluation area (**TPs 2-4**). In **TP5** it was recorded at a depth 1.04m bgl. (56.36m aOD) due to post-medieval quarrying, which was also present in **TPs 2-4**, but to a lesser extent.*

*5.2.2 In **TP1**, the brickearth **(104)** was recorded at a depth of 2.19m bgl. (c. 55m aOD) due to post-medieval quarrying which was subsequently backfilled **(102)**. This fits well with earlier evidence from a nearby evaluation trench (Cotswold Archaeology 2010, trench 2), where the brickearth was only present in the easternmost c. 2m; most of the trench (to 1.10m depth) comprising '19th century rubble' (ibid, 6) – see **Figure 2**.*

*5.2.3 The brickearth differed subtly in depth, with at least three deposits **(504 – 506)** in **TP5** constituting the uppermost surviving part of the brickearth sequence. The deposit(s) varied between a pale to light yellow/brown clay silt, silt rich clay and a mixed silt/clay/loam composition, containing rare calcareous inclusions (<1-2mm) and sub-rounded flints (<40mm).*

*5.2.4 In **TP5** the upper brickearth **(504)**, overlaid a natural calcareous lens **(505)** of 0.30m (max) thickness, which in turn overlaid a lower brickearth **(506)** characterised by a yellow/brown silt rich clay matrix containing very common calcareous inclusions (1-2mm) and moderate small sub-rounded flints (<50mm).*

2.5 Some additional background information is available. At the current stratotype (SU 134304, Sanger's or Baker's Pit), the Fisherton Bed was confirmed [3] to consist of "fine-grained inorganic sediments with a cold climate vertebrate fauna", dating from some point within the Last (Devensian) Glaciation (although certainly not to the very latest parts of that chronozone). The fauna reported at various times from Futcher's Pit and nearby exposures (to the northwest of the current stratotype and just southeast of the Highbury Avenue site), as well as other temporary exposures further east still (such as that at SU 138302), was quite diverse, with mammals (including mammoth, reindeer, red deer, woolly rhinoceros, bison, musk ox, auroch, horse, lion, hyaena, wolf, fox, artic fox, artic hare, lemming, voles, susliks), birds (including geese and eggshell fragments), molluscs (freshwater, marshy and open habitats, including cold and interstadial types) and ostracods (cool-cold) [4]. In the present author's (non-specialist) opinion, the various environments suggested by this 'odd fauna' could not be contemporary (which might explain why a few commentators have tried to shoe-horn the collection into a 'cusp' position, exactly between and interglacial and a glacial), although the 'cold-winter' group (tundra & steppe biomes, possibly with borderline boreal forest in places) is a strong and even dominant component (cf. the Pin Hole MAZ of MIS 3 [5]). Roe [6] specifically reported what appears to be an accession note accompanying a find:

> *As for artefacts, one fine sub-triangular bout coupé handaxe from Fisherton is at Salisbury Museum, recorded as having been found in loess or brickearth 'beneath the remains of a mammoth' in 1874* [typographic error – this should be 1864]. *It is white-patinated and somewhat weathered, and very flat and*

[3] GIBBARD, P.L. & PREECE, R.C. 1999. South and Southeast England. In: *A revised Correlation of Quaternary Deposits in the British Isles* D.Q. Bowen (ed), pp.58-65. Special Report No.23, the Geological Society. See also REID, C. 1903. *The Geology of the Country Around Salisbury (Explanation of Sheet 298).* Memoirs of the Geological Survey, England and Wales. (with contributions by H.B. Woodward, F.R.S., F.J. Bennett, F.G.S. and A.J. Jukes-Browne, B.A., F.G.S.). HMSO: London. Especially pp.66-70.

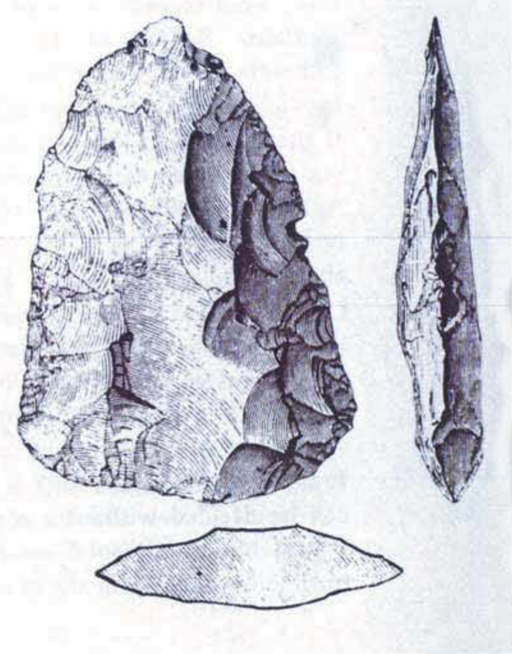
[4] Cf. GREEN, C.P., KEEN, D.H., McGREGOR, D>F>M>, ROBINSON, J.E. & WILLIAMS, R.B.G. 1983. Stratigraphy and environmental significance of Pleistocene deposits at Fisherton, near Salisbury, Wiltshire. *Proceedings of the Geologists Association* 94(1):17-22.

[5] CURRANT, A. & JACOBI, R. 2001. A formal mammalian biostratigraphy of the Late Pleistocene in Britain. *Quaternary Science Reviews* 20:1707-1716.

[6] ROE, D.A.1981. *The Lower and Middle Palaeolithic Periods in Britain* p.267. Routledge & Kegan Paul: London. The relationship with the mammoth was also noted by STEVENS, E.T. 1870. *Flint Chips: a guide to pre-historic archaeology, as illustrated by the collection in the Blackmore Museum, Salisbury* London.

well made. Sir John Evans figured and described the specimen (1897:630) [...].

2.6 The illustration (already published in 1872) in question is reproduced here:



2.7 The particular significance of this piece is that (a) it is of a type normally assumed to be (British) 'Mousterian' (later Middle Palaeolithic) in age, dating from the 'earlier to middle' part of the Devensian Glaciation (say, prior to about 40 ka [7]) and (b) the old records seem to suggest a close association between the tool and the mammoth remains (and thus a near-primary find context).

2.8 The condition and anatomical association of at least some of the other faunal material also suggests low-energy context(s). Indeed, Reid commented [8]:

> [...] *The main part of the brick-earth seems to have been a subaerial wash of loam and flints, derived from the Chalk and Eocene bluff above, and deposited at the foot of the slope. This view as to its mode of origin is borne out by the discovery of so many skeletons of lemming, coiled up as though they had been smothered while hibernating in burrows in this talus-slope.* [...].

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[7] White & Jacobi suggested a specific time slot of 59-41 ka, although they were sceptical that this 'type fossil' can be relied upon in all cases (WHITE, M.J. & JACOBI, R.M 2002. Two sides of every story: Bout Coupé Handaxes revisited. *Oxford Journal of Archaeology* 21(2):109–133). The site of Lynford (Norfolk) has produced an "MTA" (Mousterian of Acheulean Tradition) assemblage (2720 lithics, split into several separate chronological events) including *bout coupé* bifaces, set in a cool open grassland landscape, with OSL bracketing dates of 67,000 ± 5000 BP and 64,000 ± 5000 BP, interpreted as indicating late MIS 4 or early MIS 3 (BOISMIER, W., SCHREVE, D.C., WHITE, M.J., ROBERTSON, D.A., STUART, A.J., ETIENNE, S., ANDREWS, J., COOPE,, G.R., FIELD, M., GREEN, F.M.L., KEEN, D.H., LEWIS, S.G., FRENCH, C.A., RHODES, E., SCHWENNINGER,, J-L., TOVEY, K. & O'CONNOR, S. 2003. A Middle Palaeolithic site at Lynford Quarry, Mundford, Norfolk: interim statement. *Proceedings of the Prehistoric Society* 69:314-324). It has subsequently been suggested that the Lynford archaeology coincided with Greenland (DO) Interstadial 17, the termination of MIS 4 (BOISMIER, W.A., GAMBLE, C. & COWARD (eds) 2012. *Neanderthals Among Mammoths: Excavations at Lynford Quarry, Norfolk* English Heritage: London).

[8] REID, C. 1903. The Geology of the country around Salisbury. *Memoir of the Geological Survey of the United Kingdom*. p.68.

2.9 However, too much reliance should not be placed on such general background in this case. Brickearths are notoriously 'mobile' sediments and are often observed in severely reworked contexts. Indeed, the modern specialist observations of different exposures (leaving the complications of cryoturbation and decalcification deformations aside) have identified units of demonstrable current-bedded material (including sandy units and even gravel stringers), floodloam, colluvium and diamict within the Fisherton Bed, whilst true primary loess units (plausibly a source for at least some of the fines) have not been identified in the available sequences. One may also note that the typical sequence in the modern floodplain of the Nadder, above Holocene peats, often consists of silty mollusc-rich floodloam, illustrating the potential for repeated reworking of such material. Indeed, the uncertainty is underlined by the fact that the BGS have re-designated all the brickearth in this region as "undifferentiated river terrace deposits". Thus, specific evidence (such as clear internal sedimentary structure and indisputable associations of 'fragile' fossils or artefacts) for any claim of primary context is required in each and every location considered, possibly on a lateral scale of only a few metres.

2.10 Looking further afield, it is reasonable to assume that the Fisherton Bed was responding to broadly similar environmental conditions to those which were responsible for the much more extensive Langley Silt Complex, seen further east in the Thames Valley, dating predominantly from MIS 4-2 (Devensian Glaciation), although perhaps with some MIS 6 contributions in places. The Langley 'brickearths' are usually massive (due to a combination of cryo- and bioturbation) but, rarely, fine laminations (due to final wash emplacement of these originally aeolian deposits) and even palaeosol and/or krotovina (calcareous trace fossil) horizons survive, allowing more stratigraphic differentiation. The better known and studied example of the Langley Silt Complex reinforces both expectations of what one might find at Highbury Avenue and the caveats concerning the frequent reworking of this sort of sediment.

2.11 Closer to the Salisbury region, a Final Upper Palaeolithic site has been excavated at Nea Farm, Somerley (Hampshire) [9], which was located just within the top of a brickearth deposit (with an aeolian component of fine-sandy silt, showing minor post-depositional structures due to ground-ice); the geometry of the flint artefact scatter and the refitting data demonstrate that this archaeological material was in near-primary context. Whilst the artefacts themselves could not be dated directly (but are similar to assemblages known from the Allerød or just pre-Allerød phase of the Late Glacial Interstadial), the undisturbed massive brickearth, c.1 m below the present surface, gave an OSL date of 19,400 ± 910 BP (OxL-1310), plausibly representing the last time the bulk of the brickearth was fully mobilised (in sunlight), probably by colluviation [10].

2.12 The larger collections of Palaeolithic finds (especially bifaces or 'handaxes' which Roe (ibid., p.213) called "prolific but derived and probably mixed") from sand & gravel pits in the general vicinity are more likely to be of Lower Palaeolithic (pre-Devensian, probably pre-MIS 6) age and to come from fluvial terrace sequences that are stratigraphically lower (older) than the primary occurrence of the Fisherton Bed but which may now lie, or once have lain, altitudinally above the Highbury Avenue site. Potentially, such 'old' artefacts

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[9] BARTON, N, FORD, S, COLLCUTT, S, CROWTHER, J, MACPHAIL, R, RHODES, E and VAN GIJN, A, 2009, 'A Final Upper Palaeolithic site at Nea Farm, Somerley, Hampshire and some reflections on the occupation of Britain in the Late Glacial Interstadial', *Quartär,* 56:7-35.

[10] The earliest Upper Palaeolithic, the LRJ, dating from approximately 38-36 ka, might also occur within an MIS 3 brickearth, the nearest substantial occurrence being at the Beedings, Pulborough (Sussex). Cf. FLAS, D. 2011. The Middle to Upper Paleolithic transition in Northern Europe: the Lincombian-Ranisian-Jerzmanowician and the issue of acculturation of the last Neanderthals. *World Archaeology* 43(4): 605-627.

could therefore occur in a derived state within the brickearth. Wymer noted [11] that the most prolific collections were made in gravels only 20 m above the modern valley floor (i.e. the terrace deposits are at 65-75 m AOD); he suggests that these gravels may be correlative with Terraces 7 or 8 of the Avon sequence below Hale [12]. However, it is the case that the Avon tributaries (such as the Nadder) have largely incised on or near their current thalweg, such that any surviving terrace remnants are extremely small and 'fragmented'; only a widespread and lengthy research effort would stand any chance of producing a reliable terrace sequence in this vicinity.

2.13 Overall, the 2006 BGS Internal Report [13] is probably the most comprehensive summary for this area to date; relevant extracts are attached to the end of present report as Appendix A. The BGS recognise a terrace obviously lying below the Fisherton brickearth (1.5 to 5 m above the current river) as Avon Terrace 4 (apparently on morphostratigraphic grounds) but still decline to correlate the gravelly material from the higher levels in the local bluffs, leaving them as "undifferentiated". At least the lower terrace seems also to contain some faunal remains, with reports of mammoth teeth and reindeer antlers from the old workings. A correlation with MIS 4 (early Devensian) for this terrace gravel has been suggested [14]; if this is correct, any included archaeology will probably be older material in a derived context (originating from reworking of higher gravels), since there are no known primary archaeological sites in Britain of this age.

3. Lithostratigraphy

3.1 The composite sequence (with slots cut across the treads of steps to ensure continuity) is described (from the top downwards), with reference to local relative 'height' (zero at the top, depths in centimetres); the 'height' was calculated simply by summing the intervals measured on the individual step risers/faces (thus the 'composite column base level' may differ slightly from the true basal altitude of the trial pit). The 'Unit' attribution is an interpretative designation, explained in Section 4 (Discussion) below. The staff (red & white) in some of the figures shows 50 cm divisions, the fine scale (black & white) in other figures shows 1 cm divisions. Field-damp Munsell colours are given; note that most sediments that are silt-dominated dry to c.10YR 8/3.

STEP	HEIGHT	DESCRIPTION	UNIT
		(Made ground largely removed)	
1	0-c30	Disturbed top surface; topsoil; dark yellowish brown 10YR 3/4; biologically brecciated (fragmented) lower contact. [Fig.2]	A
1	30-50	Fine-sandy silt; reddish yellow ('buff') 8.5YR 6/6; crypto-laminated [i.e. having a strong, roughly horizontal fissility, often with fine sand grains on fracture planes) in patches; some very fine chalk pellets. [Fig.2]	B

[11] WYMER, J.J. 1999. *The Lower Palaeolithic Occupation of Britain* 2 Vols. Salisbury: Wessex Archaeology & English Heritage. See Vol 1, p.113.

[12] The site of Harnham (SU 1520 2785) has produced undisturbed Lower Palaeolithic artefacts (refitting handaxe assemblage) in a sand body at the very top of the fluvial sequence of the 72 m AOD Terrace 7 of the Avon. There is an OSL determination which would suggest a date of c.250 ka, in late MIS 8 or early MIS 7 (WHITTAKER, K., BEASLEY, M., BATES, M.R. & WENBAN-SMITH, F.F. 2004. The lost valley. *British Archaeology* 74:22-27). There is also an AAR determination (on *Bithynia*) which would indicate an age between late MIS 9 to early MIS 7 (PENKMAN, K., COLLINS, M., KEEN, D. & PREECE, R. 2008. *British Aggregates: An Improved Chronology Using Amino Acid Racemization and Degradation of Intercrystalline Amino Acids (IcPD)* Research Department Report No.6. English Heritage: London).

[13] HOPSON, P.M., FARRANT, A.R., NEWELL, A.J., MARKS, R.J., BOOTH, K.A., BATESON, L.B., WOODS, M.A., WILKINSON, I.P., BRAYSON, J. & EVANS, D.J. 2006. Geology of the Salisbury Sheet Area. *British Geological Survey Internal Report* IR/06/011. Nottingham, British Geological Survey (NERC).

[14] WESTAWAY, R., BRIDGLAND, D. & WHITE, M. 2006. The Quaternary uplift history of central southern England: evidence from the terraces of the Solent River system and nearby raised beaches. *Quaternary Science Reviews* 25:2212-50.

1	50-c52	Relatively persistent laminae and stringers of fine chalk pellets, silt intervening; wavy form. [Figs. 2-3]	B
1	52-71	Clayey silt; base colour strong brown 8YR 5/6 but with 'grey-green' mottles and lenses, and 'rust-red' Fe-pseudomorphs (Fe = iron 'sesquioxides') and lenses; laminated (sometimes at <1 mm) to micro-lenticular bedding throughout, with some deformation, biological (root and burrow) and geological (possibly cryogenic) in places; common rootlet pseudomorphs but no homogenised bioturbate horizons; rare chalk pellets and rare finest gravel/granules, floating; possible very small/shallow cut-and-fill features near top; overall structure clearer in top half, more disturbed in lower half; sharply erosive base, with rills of c.10-8 cm frequency and 2-3 cm amplitude. [Fig.2 and detail in Fig.3]	B
1	71-92	Fine-sandy silt with chalk pellets; reddish yellow ('buff') 8.5YR 6/6; crypto-laminated in patches; rare fine gravel clasts; restricted stringers of flint granules and chalk pellets, wavy. [Fig.2]	B
1	92+	See Step 2	
2	92-106	Fine to medium flint gravel, nodular, rounded and angular clasts mixed; chaotic structure, with long axes at all angles; mostly matrix-support in silty diamict; contorted form, showing up to 20 cm contact relief locally. [Fig.4]	C
2	106-116	Silty diamict; reddish yellow to light brown 8.5YR 6/5-4; largely massive; common chalk ('white-to-cream') granules; possible origin (alternatively, at summit of the 92-106 interval – uncertain because of earlier archaeological trench immediately above) of medium-scale ice-wedge cast (that traverses most of Unit C vertically). [Fig.4 showing ice-wedge cast; cf. Fig.5 which also shows burrow and root casts penetrating from Unit B above.]	C
2	116-122	Fine gravel/grit and chalk debris; undulating. [Cf. Fig.4]	C
2	122-123	Persistent finest-sandy silt bed, contorted with varying thickness. [Cf. Fig.4]	C
2	123-124	Fine gravel/grit and chalk debris floating in silty matrix; undulating. [Cf. Fig.4]	C
2	124-135	Finest-sandy silt diamict; reddish yellow ('buff') 8.5YR 6/6; largely massive; common chalk ('white-to-cream') granules; undulating. [Cf. Fig.4]	C
2	135-164	Silty diamict with common fine gravel/grit and chalk debris; light brown ('buff') 8.5YR 6/4; massive; undulating contacts. [Cf. Fig.4]	C
2	164-176	Fine to medium flint gravel in chalky silty matrix; massive, contorted contacts. [Cf. Fig.4]	C
3	176-200	Fine-sandy silt diamict; reddish yellow 7,5YR 6/6; locally apparently massive but with 'patches' of laminations and crypto-laminations and stringers of finest chalk pellets; contorted. [Fig.10]	C
3	200-205	Fine to medium flint gravel and granules, matrix-poor but containing some sand; contorted contacts; very sharp lower boundary but no channelling in available sections. [Figs. 6 and 10]	C
3	205-225	Slightly clayey fine-sandy silt; dominantly laminated but with fine lenticular bedding intervals in places; various colours, base colour reddish yellow ('buff') 8.5 YR 6/6 to reddish brown 5YR 5/4, some 'rust-red' or 'grey-green' features (pseudomorphs, mottles, lenses); 'chalky' greyish (reduced colours) root casts in, apparently penetrating from top surface; some Fe- and Mn-pseudomorphs (manganese hydroxides) of roots, some Mn on partings. [Figs. 6, 7a and 10]	D
3	225-228	Lighter silt with common chalk pellets and rare finest flint gravel/granules. [Figs. 6 and 10]	D
3	228-248	Dominantly fine-sandy silt; laminated but with fine lenticular bedding intervals in places; some fine chalk pellet stringers Fe-pseudomorphs of rootlets, especially towards top; uppermost persistent lamina of pale brown 10YR 6/3; variegated colours but may be reddish brown 5YR 5/4, even 4/4 in traces; minor ice-wedge casts; very persistent thin (<2 mm) laminae of clean medium sand (particularly obvious example at a depth of 229), yellowish brown10YR 5/4 or 'greener; deformed and micro-faulted (there could be some minor ripple-forms in this interval but it is not possible to be sure, given the post-depositional deformation). [Figs. 6, 7b, 7c, 8 and 10]	D
3	248-249	Chalk pellet interval; undulating. [Figs. 6 and 10]	D
3	249-256	Dominantly fine-sandy silt; laminated; deformed. [Figs. 6 and 10]	D
3	256-258	Chalk pellet interval; undulating. [Figs. 6 and 10]	D
3	258-290	Slightly clayey fine-sandy silt; dominantly laminated; variegated (colours quite 'strong' when fresh but fading quickly with oxidation); common Fe-	D

		pseudomorphs of rootlets; fine carbon ('charcoal') flecks; many cycles of more or less oxidised/reduced conditions; common bioturbation and general blotchiness but bedding never obliterated (thus, no mature palaeosols); rare tiny cut-and-fill structures, rare wedge/crack casts (<5 cm vertical dimension – not classic desiccation features more like ground-ice structures). [Figs.6, 9 and 10]	
3	290-300	Light 'buff' silty diamict; poorly laminated to crypto-laminated. [Figs. 6 and 10]	D
3	290+	See Step 4	
4	290-297	Clayey silt but with 'floating' sand grains; finely laminated or lenticular; although distorted, apparent very small-scale (<10 cm wide in section, c.1-2 cm thick) trough cross-bedding in rare instances; Fe on partings gives 'ginger'7.5YR 6/8+ (high chroma) before oxidation; sharp lower boundary, wavy. [Figs.10 and 11]	D
4	297-320	Clayey fine-sandy silt; very poorly laminated or crypto-laminated, structure difficult to observe; light yellowish brown 10YR 6/5; diffuse to very diffuse lower boundary. [Figs. 10 and 11]	E
4	320-330	Similar to interval above but with common chalk pellets; diffuse lower boundary [Fig.11]	E
4	330-350	Clayier fine-sandy silt; still some traces of lamination; chalk pellets, some quite large (<1 cm); a little fine flint gravel, floating; reddish yellow 8.5YR 6/6; diffuse lower boundary. [Fig.11]	E
5	350-362	Very silty fine sand; crypto-laminated; fine chalk pellets; carbon flecks; reddish yellow ('buff') 8.5YR 6/6; sharp lower boundary. [Fig.12]	E
5	362-369	Diamict with small to medium flint gravel and chalk pellets; sharp, undulating lower boundary. {Fig.12]	E
5	369-377	Very silty fine sand; crypto-laminated; fine chalk pellets; carbon flecks; reddish yellow ('buff') 8.5YR 6/6; relatively sharp lower boundary. [Fig.12]	E
5	377-404	Clayey fine sand, with clay intervals and a few minor (patchy) medium sand intervals; rather irregular but still bedded; very common chalk pellets. [Fig.12]	E
5	404-424	Clayey silt; blotchy bioturbation but traces of lamination throughout; Fe on partings and pseudomorphs of rootlets; variegated colours; very irregular lower contact. [Fig.12]	E
5	424-440	Mixed, structureless/chaotic sandy silt with very common medium to coarse flint gravel but matrix-support; irregular lower contact. [Fig.12]	F
5	440+	Medium to coarse, almost exclusively flint gravel (very rare sarsen and quartzite), clasts usually quite angular, including broken nodules; good clast-support; matrix of mixed coarse sand, granules, clayey silt and chalk, presumably infiltration into original openwork. [Fig.12 shows main gravel texture only – clasts replaced after excavation].	F

4. Discussion

4.1 Unit A is an organic soil. The base is clearly biologically erosive, with no obvious horizonation affecting the underlying sediments, suggesting that the topsoil material may have been 'placed' and/or 'cultivated' recently.

4.2 Unit C is best described next, since it is of a particular and relatively simple type. The sediments are 'diamicts' (that is, poorly sorted, with many size grades irregularly present), although fine-sandy silt ('brickearth') is always dominant. There is no internal bedding structure – these sediments are thus said to be 'massive'. Included stones are set at all angles, often on end. There may be 3-4 cycles in this sequence (with weak colour changes and/or stonier stringers to show demarcation), each of which represents a relatively slow mass movement event. The term 'solifluction' may be used; in the present case, 'gelifluction' may be more apposite, since there are signs of ground ice (which facilitates such mass movement, by increasing water content during superficial melting whilst blocking infiltration due to persistently frozen deeper zones). There is at least one medium-scale ice-wedge that cuts through the whole thickness of Unit C.

4.3 Mass movement deposits can contain disturbed (dissociated) and dispersed objects (artefacts, fossils) of any age older than the particular movement event (especially objects derived from any available near-surface deposit broadly 'up-slope', northwards in the present case); such mixed contexts are usually of low priority.

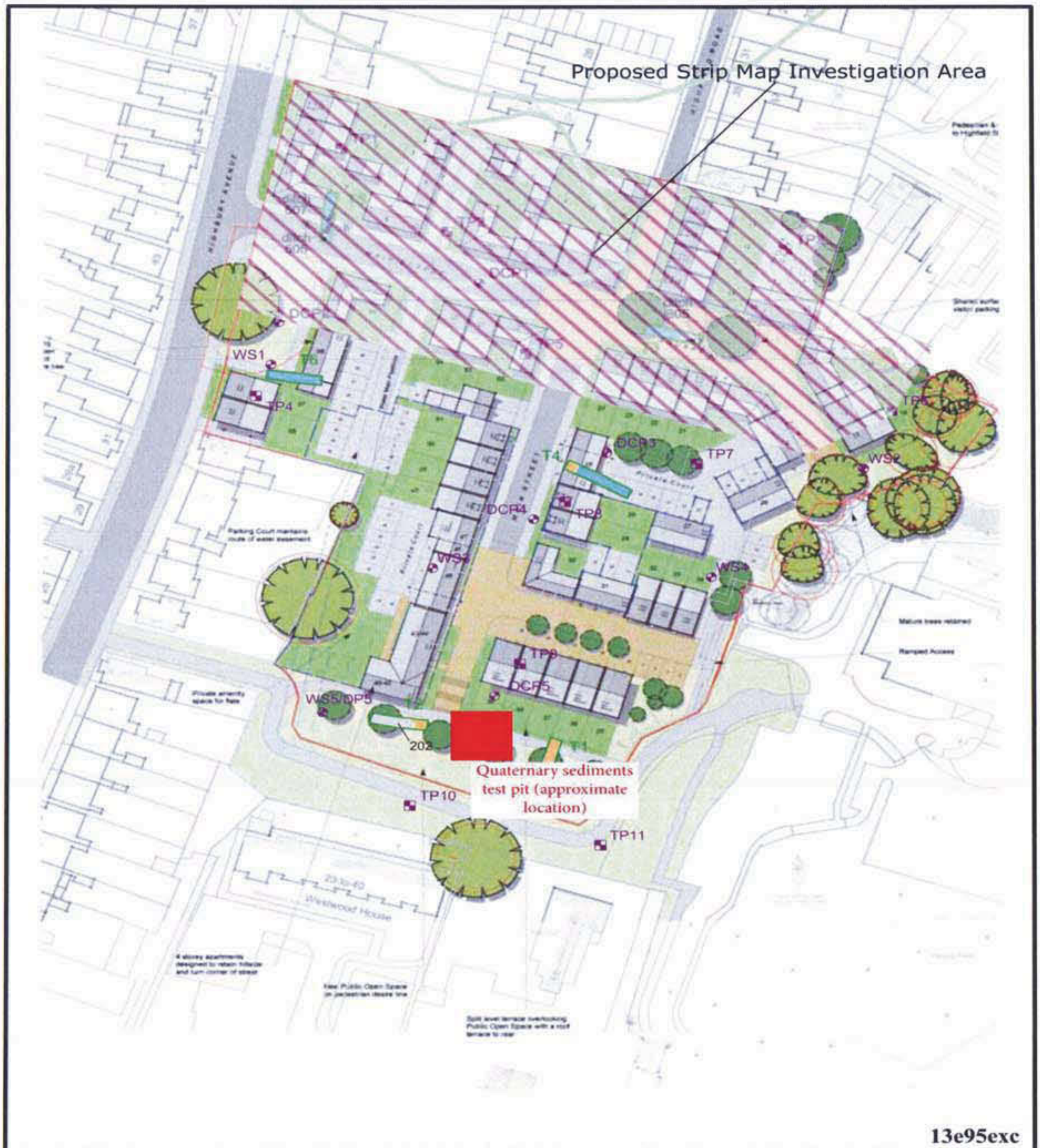
4.4 Units B and D & E are broadly similar. The key attributes are a dominance of fine-sandy silt ('brickearth') coupled with almost universal internal structure, mostly laminated but also fine lenticular. These attributes indicate deposition in still or slowly flowing water. The fact that 'cut-and-fill' structures (temporary scoops and even channel-forms) are so rare, and of such small scale when actually present, shows that no persistent currents crossed this area. In fact, the strongest currents are probably indicated by the extremely thin (and thus temporary) medium sand laminae that occur at a few levels in the sequence. This area comprised back-swamps, pools, even marshy zones. There are many traces of biological activity (dominated by roots and rootlets) but there are no significant 'homogenised' horizons which would indicate stable palaeosols. There are nevertheless a few 'ripened' intervals (such as the top of Unit D) which may have been a little more stable than usual. The land was certainly not always covered by water, since there are both very small-scale ice-wedge casts (which are not produced under standing water) and some instances of burrowing that resemble the traces from small terrestrial mammals and insects. It is likely that horizontal excavation at some levels would expose 'emergence surfaces', with rain-drop impacts, desiccation cracks and clay curls, and even hoof/foot prints. One may note that earlier excavators of the Fisherton brickearths seem to have reported true calcretes and carbonate rhyzoliths (calcitic forms requiring evaporation within aerated soils), which would indeed indicate that there had been drier zones in the vicinity.

4.5 Within these 'wet' deposits, there are still diamict incursions, usually in a form that indicate that much of their original fine matrix has been washed out to leave the coarser elements (fine gravel and chalk pellets) as a lag. Such material could have originated locally by bank-collapse or from slightly further afield by occasional mass movement down neighbouring slopes. The dumping of diamicts onto the 'wet' areas could only help to restrict the drainage and perpetuate the marshy conditions. A differentiation has been made here between Units D and E on the grounds that E (the lower, much less structured interval) may contain some input from faster mass movement or debris flow (i.e. more fluid movement than solifluction/gelifluction). Such events are very common near the base of cold climate slopes, where solifluction lobes and turf mats may sometimes burst, liberating mud onto the flats below. This cannot have become a dominant mechanism, however, since strong debris flow is usually itself erosive and will channel underlying deposits (not seen here).

4.6 Ancient man would not have camped in the generally 'wet' environments indicated for Units B and D & E. However, such areas would certainly have been used to hunt game of various sorts, from wetland birds to large mammals. There may even have been opportunities for fishing. Furthermore, the generally high sedimentation rate would serve to cover any discarded material quickly in many cases, leading to high quality primary archaeological contexts for particular events, such as the butchering of a game animal. The fact that nothing was found in the current trial pit does not detract from this conclusion – an archaeological site could lie mere metres away. Similarly, the presence of chalk in most beds and the positive (if sometimes weak) dilute HCl-reaction would indicate that both bone and shell, as well as other calcareous remains (e.g. ostracods), should be capable of surviving in at least some of these sediments. Mollusc shell is the most soluble of organic carbonates and no traces were noted during the present work; it might nevertheless be possible to retrieve small aquatic molluscs and perhaps ostracods from samples showing both good lamination and a reasonable chalk content. Unfortunately, the shelly marl, noted by some excavators at the base of the Fisherton brickearth sequence, is certainly not present here. The lack of well-sorted sands means that optimal OSL dating material is lacking but it may be possible to gain reliable dates by targeting sandier units (especially those with medium sand laminae). Whilst it is entirely plausible that the sedimentary sequence observed at the Highbury Avenue site dates from MIS 3, known to have been a period of generally cold-cool but strongly fluctuating climate, it would be reassuring to have chronometric dates; no OSL results have yet been published from any Fisherton Bed site.

4.7 The whole sequence between Units E to B is consistent with a back-floodplain setting, rather than with significant hillslopes. It is to be expected that brickearths with a more colluvial structure, together with coarser diamicts (even 'coombe rocks') will occur up-slope to the north. In as much as such deposits would have arisen under slightly higher energy conditions, they are likely to provide lower quality contexts, even though they may have been attractive for a wider variety of human activities.

4.8 Whilst the exposure of Unit F at the very bottom of the trial pit was minimal, the fact that the coarser gravel showed clast-support suggests that this is likely to be the top of the true fluvial terrace (Terrace 4), with the expected texture and angularity for a cold-climate braided river.



Former Highbury and Fisherton Manor Schools, Highbury Avenue, Salisbury, Wiltshire
Proposal for an archaeological excavation- Quaternary test pit
Fig. 1. Location of trench

THAMES VALLEY ARCHAEOLOGICAL SERVICES

Figure 1

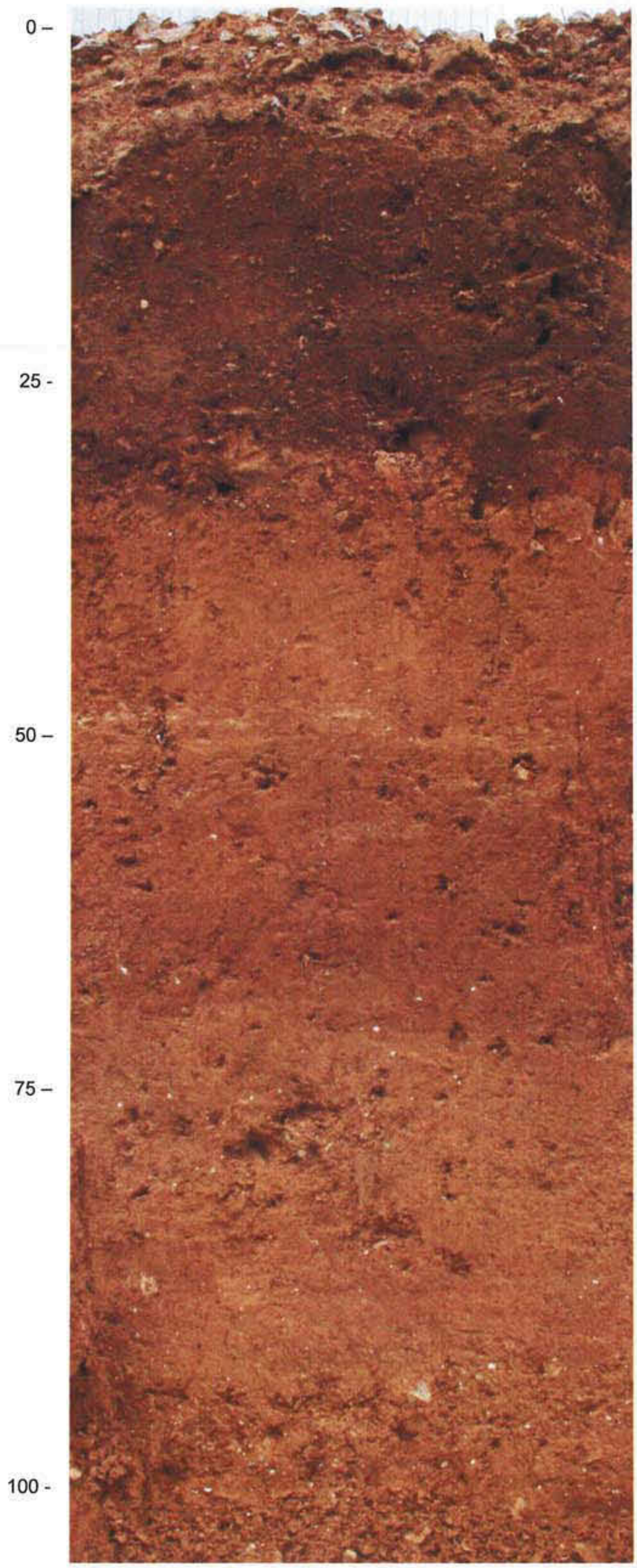


Figure 2 – Step 1 (Units A-C)

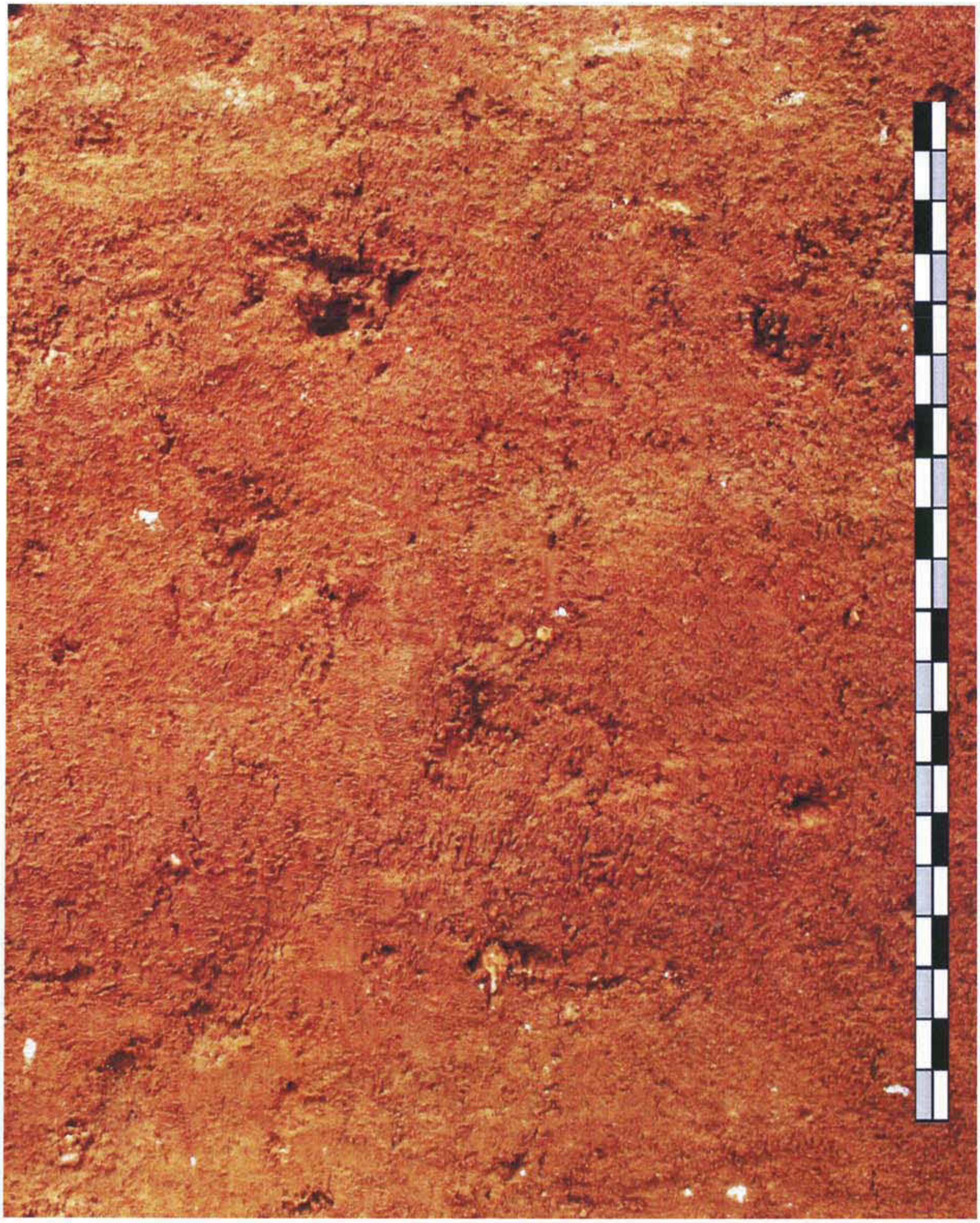


Figure 3 – 52-71 Interval (Unit B) (forced contrast to reveal structure)

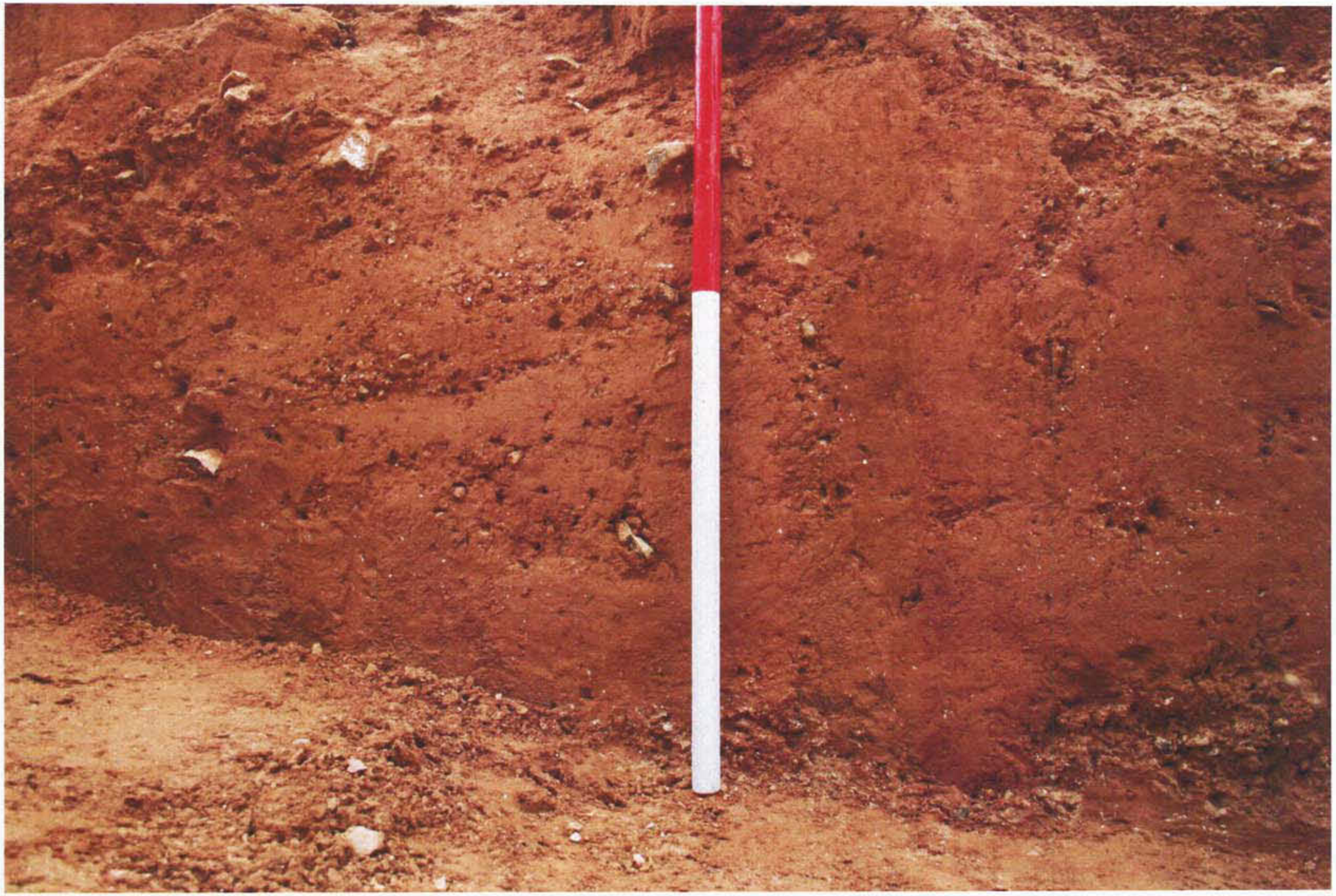


Figure 4 – Step 2 (Unit C) (note ice-wedge cast right of staff)

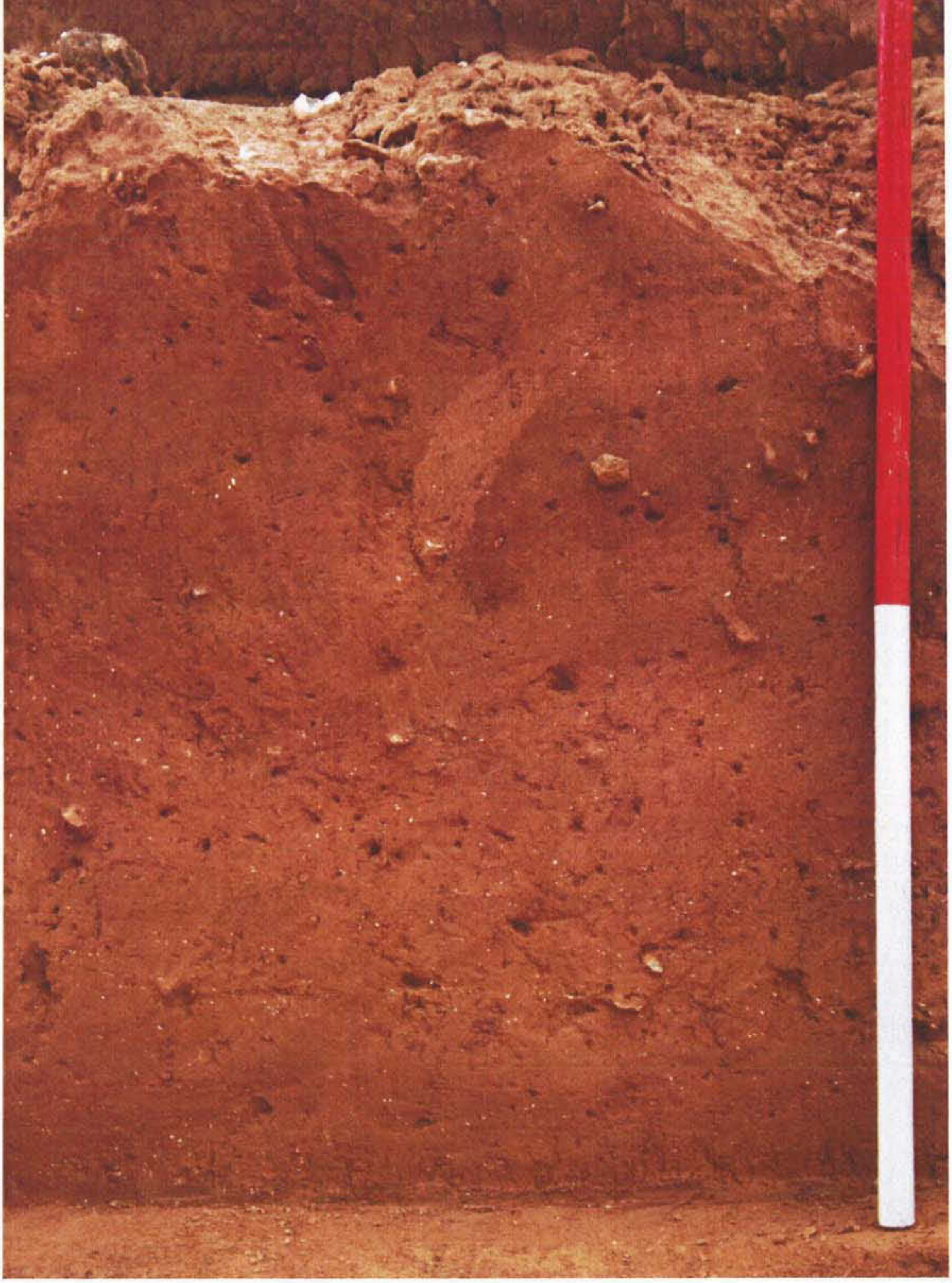


Figure 5 – Step 2 (Unit C) equivalent to NE
(note burrow and root casts from above)

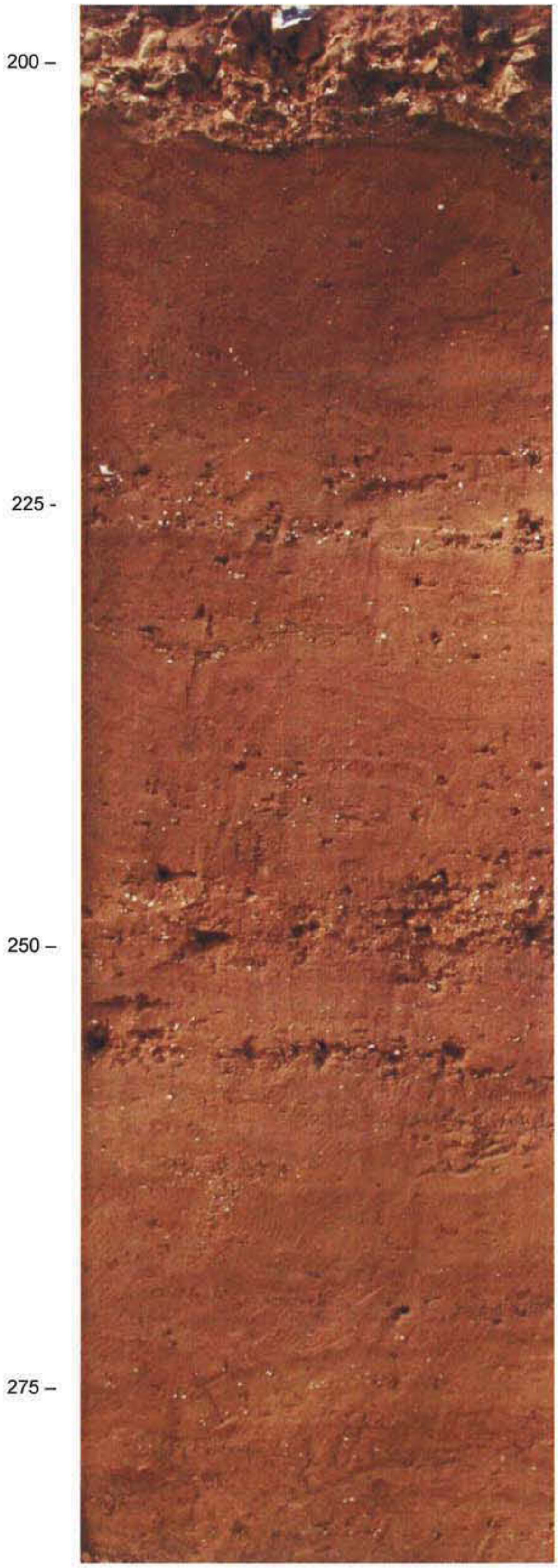


Figure 6 – Step 3 (Units C-D)

(a)

Rootcasts (reduced, greyish colours) at top of Unit D


(b)
Fe-pseudomorphs ('rust-red') of rootlets

(c)

Persistent medium sand lamina c.2 mm thick at most (example)

Figure 7 (a-c) – Upper Unit D details

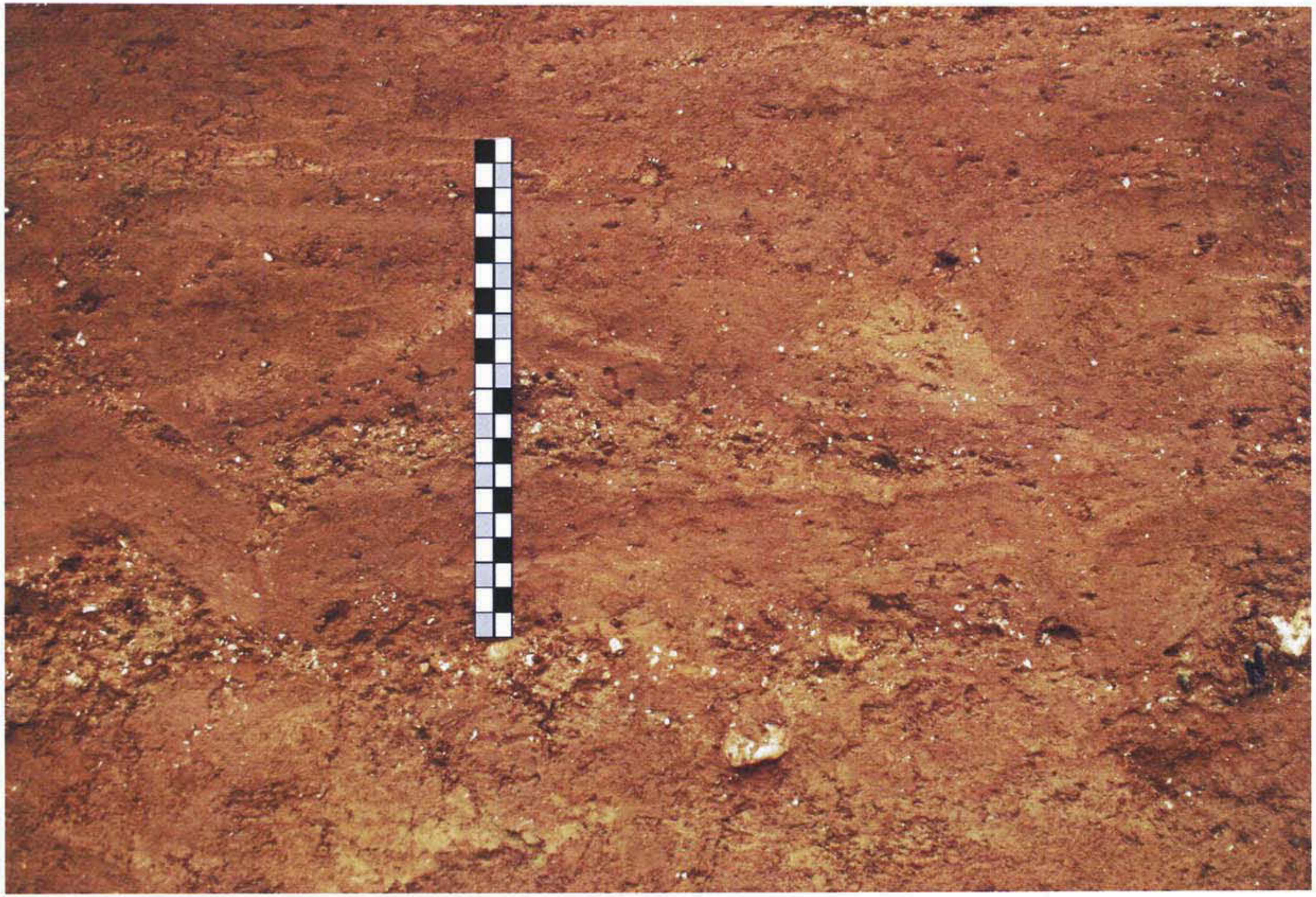


Figure 8 – Central Unit D detail (west face) (note minor ice-wedge casts at equivalent to 228-248 in main sequence)

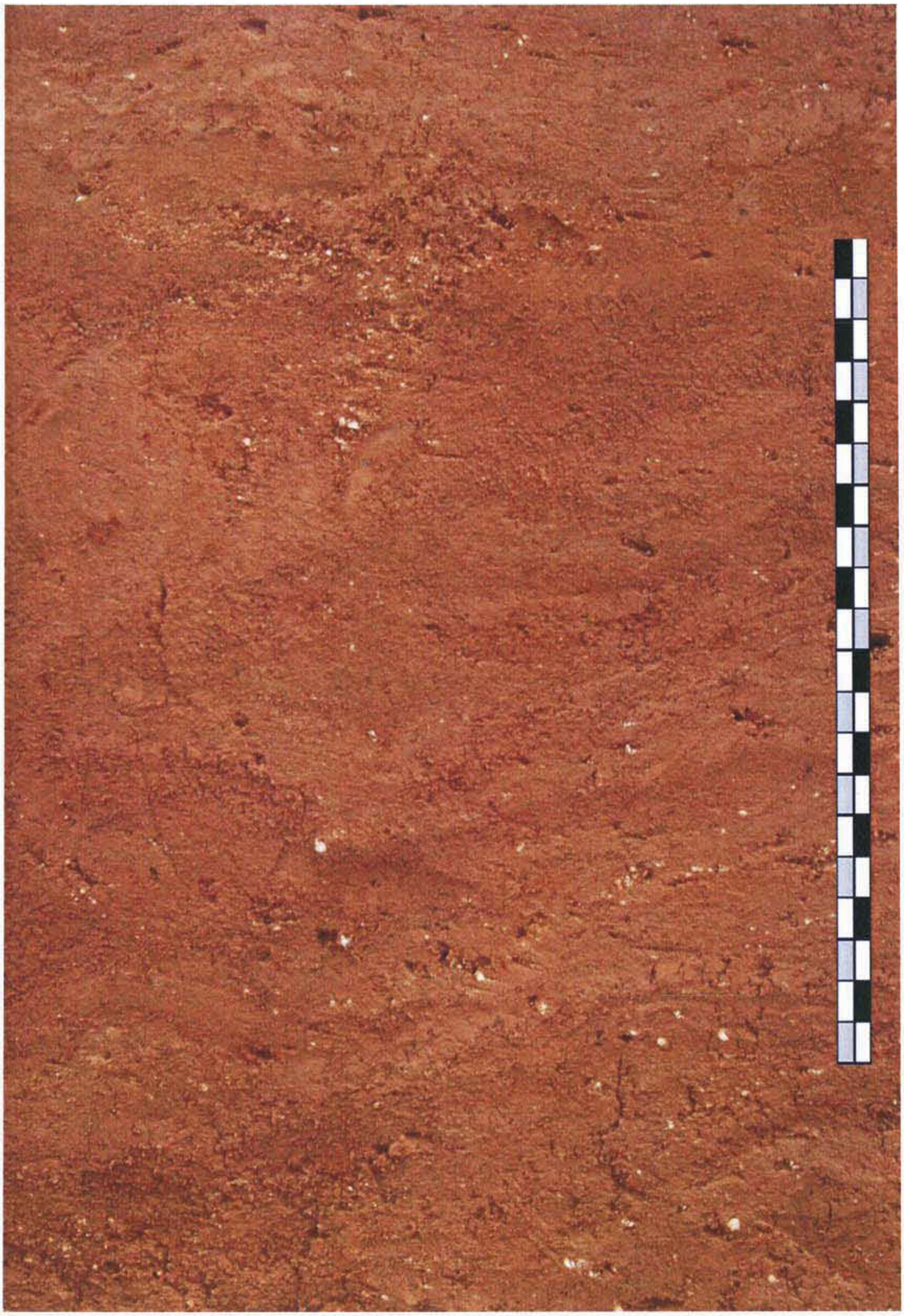


Figure 9 – Lower Unit D details
(association of cracking/wedging, minor bioturbation structures and deformation of laminated bedding – 258-290 in main sequence)

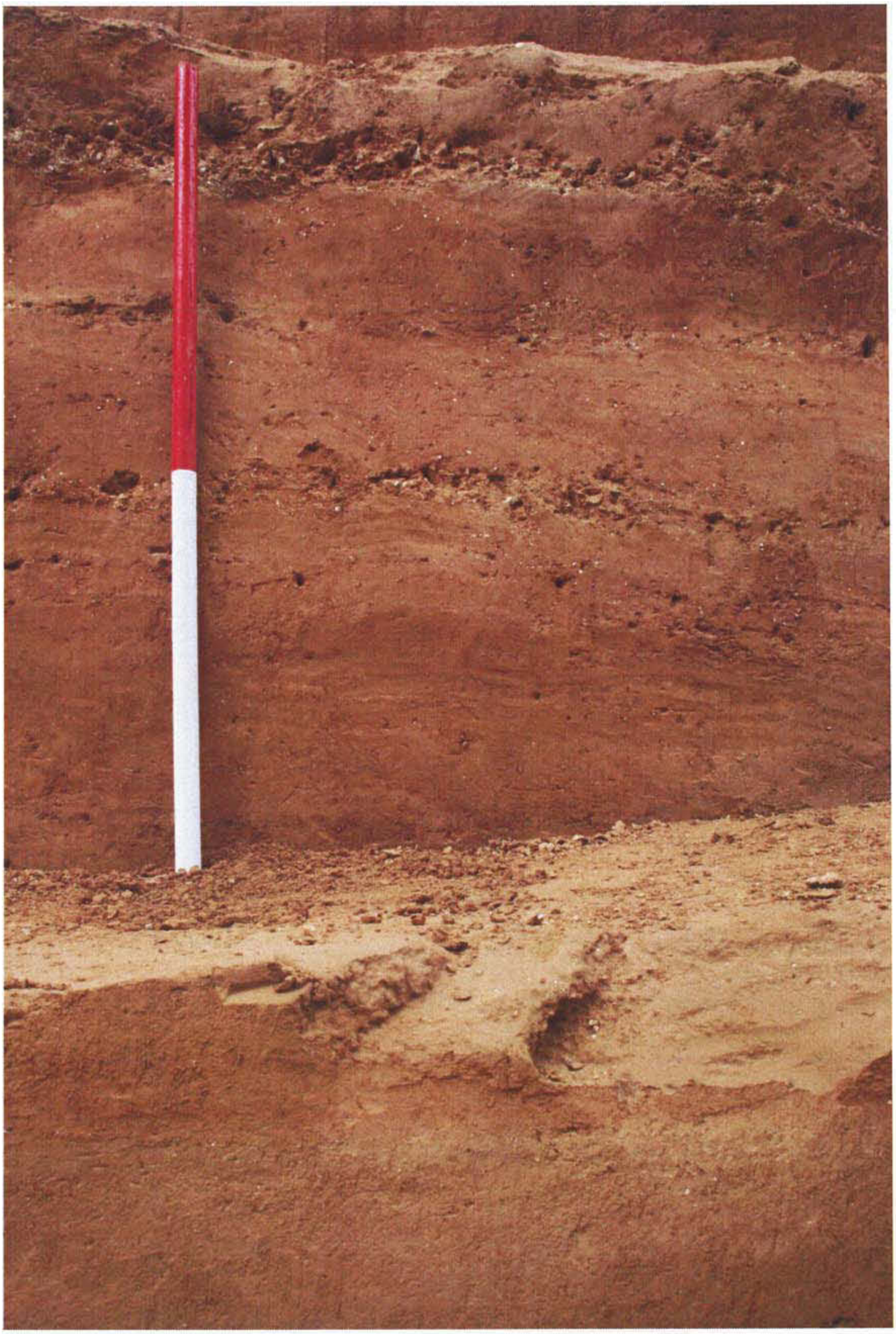


Figure 10 – Step 3 (Unit D) and top of Step 4

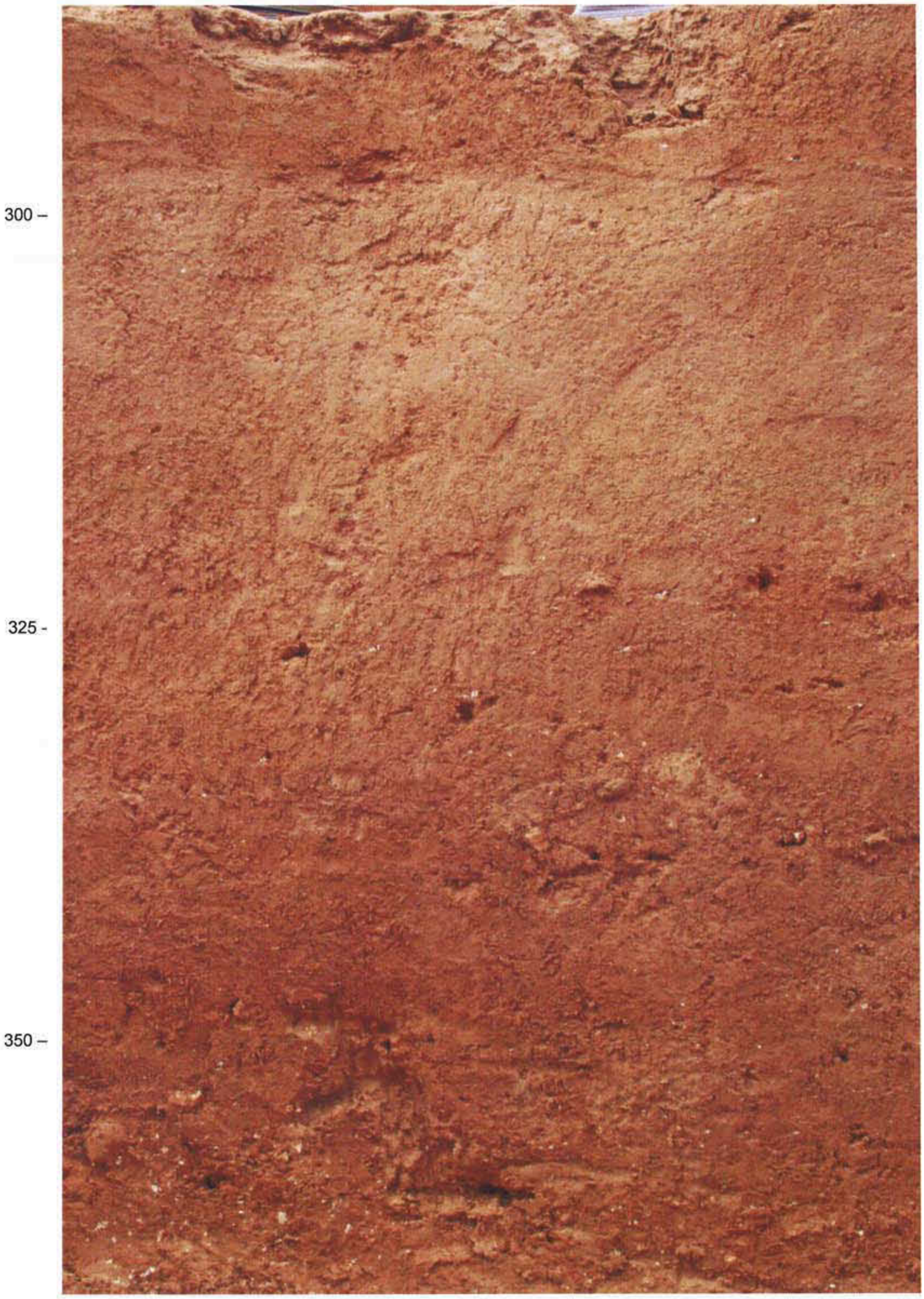


Figure 11 – Step 4 (Units D & E)

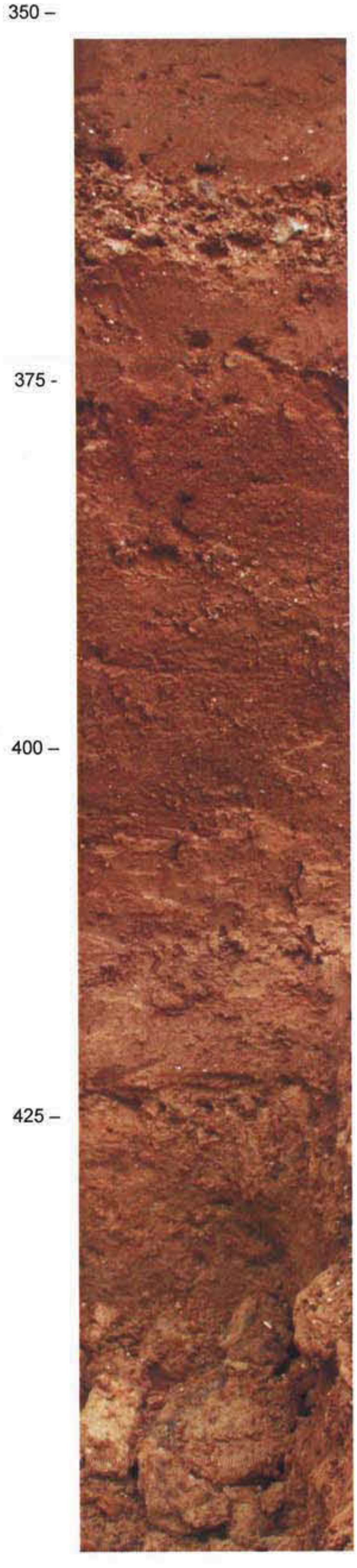


Figure 12 – Step 5 (Units E & F)

APPENDIX A: BGS Extracts

Natural Environment Research Council
British Geological Survey
Onshore Geology Series
Geology of the Salisbury Sheet Area
Report on the Geology of Sheet 298 Salisbury and its adjacent area.
A compilation of the results of the survey in Spring and Autumn 2003 and from the River Bourne survey of 1999
Internal Report IR/06/011
P M Hopson, A R Farrant, A J Newell, R J Marks, K A Booth,
L B Bateson, M A Woods, I P Wilkinson, J Brayson and D J Evans
Geographical index
UK, S England, Wiltshire, Hampshire, Salisbury, River Avon, River Wylie, River Nadder, River Bourne, River Ebble
Subject index
Geology, Quaternary, Palaeogene, Cretaceous, Jurassic, Chalk and concealed geology
Bibliographic reference
P M Hopson, A R Farrant, A J Newell, R J Marks, K A Booth, L B Bateson, M A Woods, I P Wilkinson, J Brayson and D J Evans. Geology of the Salisbury Sheet Area. *British Geological Survey Internal Report* IR/06/011
 Keyworth, **Nottingham, British Geological Survey 2006**
iii

[...]

8.6 River Terrace Deposits (Brickearth)

This term is reserved for the deposits formerly called Brickearth or in some papers the Fisherton Deposits or Fisherton Brickearth. These were exposed in a number of brick-pits between Quidhampton [SU 113 310] and the city centre Old Manor Hospital site [SU 136 304], north of Salisbury Railway station. The outcrop shown on the map has been identified on the basis of its generally flat or low southerly slope and associated silty clay soils with some pebbles, between the gravel rich soils of the fourth terrace flat to the south and the clayey gravels on the steeper slopes to the north. The deposits rest on the fourth terrace (see below) forming the north bank of the River Nadder floodplain. It is plain from the descriptions in the literature that the deposit thins upslope to the north where progressively more soliflucted materials interdigitates with the deposit. The brick-making industry in this area ceased around 1900 and descriptions in the memoir (Reid, 1903) essentially reiterate those of Prestwich and Brown (1855). Since that time all of the sites have degraded and the majority were built over as Salisbury expanded north-westward into the Bemerton district. It is not clear whether all of the occurrences mentioned in the early literature are related, indeed those described by Prestwich and Brown (1855) as being "east-north east of Wilton in the railway cutting" [? SU 110 313] and "on the railway beneath the High road near Bemerton" [? SU 123 308] are now mapped as a valley head deposit albeit perhaps overlying 'brickearth' although generally with a greater flint gravel content perhaps indicating subsequent remobilisation incorporation of head.

Delair and Shackley (1979) gave a valuable account of the Fisherton Brickpits including their known stratigraphy and faunal lists (to which readers are recommended), and published the first locality map placing the former named sites in the context of the present road network (Figure 66). Green et al. (1983) gave an account of sediments and included faunas exposed at temporary sections [SU 138 302], at the junction of the Devizes and Wilton Roads northeast of the Railway Station at Fisherton in 1974, during the construction of the Salisbury northern relief road (Figure 67). They gave the name of the Fisherton Terrace to the underlying coarse gravel materials, whilst Delair and Shackley (1979) referred to the same gravel as the Bemerton Terrace.

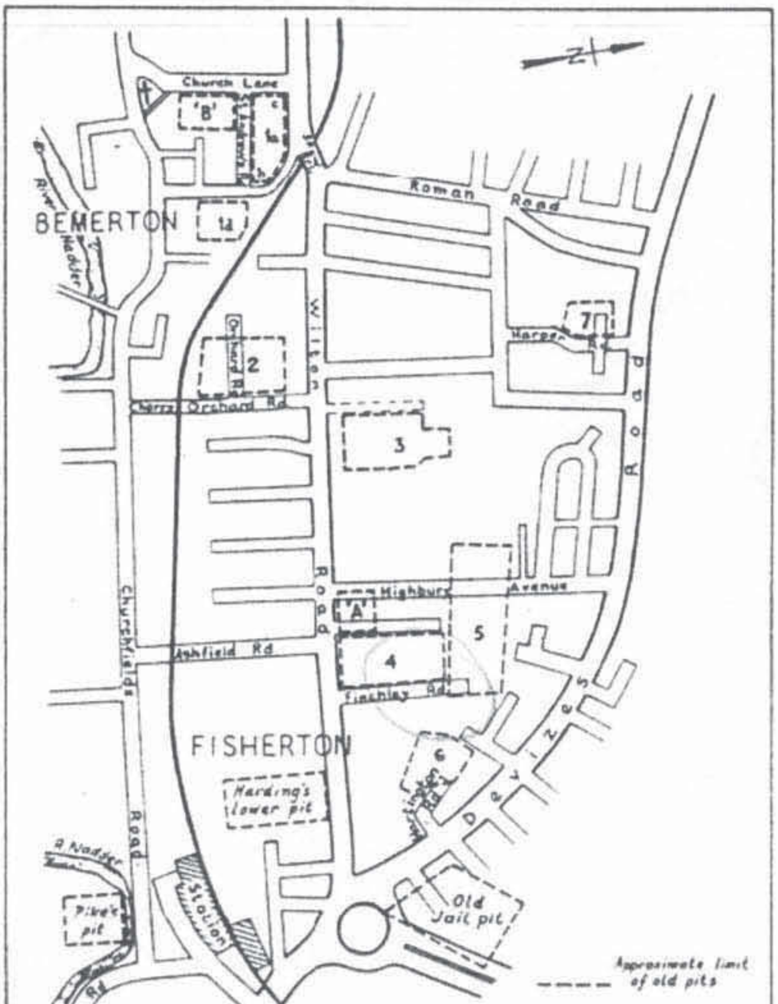


Figure 66: Locations of the former Brick Pits in the Fisherton/Bemerton area.

[p.185 above]

The 'brickearths' have yielded a rich fauna of mammals and mollusca whilst they were being worked in the early to late 19th century and the beds achieved some notoriety because of the distinct 'Arctic' character of the mammals identified. Reference to these deposits goes back as far as Lyell (1827) and there are numerous references to them in the latter half of the century

(Prestwich and Brown, 1855; Blackmore, 1864, 1867; Evans, 1864; Tylor, 1869; Blackmore and Alston, 1874; Kennard and Woodward, 1901). Reid (1903) in the memoir for the district also recognised that "the associated land and fresh-water mollusca call for no remark, they are all living British forms". Delair and Shackley (1979) suggest that the Fisherton mammalian fauna must date to "the extreme end or at the very beginning of an interglacial, in particular the last (Ipswichian) interglacial" and went on to say that the molluscan fauna "suggests that a substantial proportion of the fauna lived during the cool *Pinus* zone" and that "it is not improbable that the more thermophilous animals survived into the early Devensian". This age interpretation is further substantiated by evidence from the included hand-axe morphology. Green et al. (1983) examined the molluscan and ostracod assemblages from their exposure and
concluded "the age of the Fisherton fauna cannot be demonstrated conclusively" but went on to suggest that the ostracods represent an early Devensian age whilst the mollusca indicate an early rather than late glacial episode.

The deposit is very variable and comprises both fluviatile and soliflucted beds. The most comprehensive account of the lithologies present is found in Green et al. (1983). Four "groups" are described and given in order of superposition below: -

Lithology	Interpretation
d. STONEY CLAY, confined to the uppermost part of the sections where it comprises dark reddish-brown clay containing bleached angular flint fragments. Sharp lower boundary in places piped into underlying sediments	Solifluction material
c. SANDS and LOAMS, these occur either on the gravel or as isolated masses apparently within the gravel. Their texture is variable. The most common sediments are greenish grey sands which may be succeeded upwards by buff-coloured silty clays. Sands are coarse-grained passing up into fine-grained Bedding is often preserved but is usually disturbed. Calcareous material is locally abundant either as sheets on bedding planes or as shell material in masses at the base with tubular structures perpendicular to the bedding. In general they lack the high silt content associated with true aeolian 'brickearth' deposits	Probably represent a mixture of alluvial sand and silt and clay in backwater situations with some slopewash
b. GRAVEL, comprises coarse, iron-stained river gravel, composed largely of flint. In places it penetrates the chalk rubble in steep-sided pipes, but is itself penetrated by overlying sediments so that its thickness is variable. Contact with the underlying chalk rubble is sharp.	Fluviatile
a. CHALK RUBBLE, comprises poorly sorted angular and subangular chalk fragments, and broken but unrolled flints in a paste of chalk debris. In places this material occurs as crude beds alternating with beds of less compact chalk rubble containing sand and rolled flint. In the lower part of the rubble, thin seams of fine chalk gravel occur. Upper surface uneven	Downslope accumulation by hillwash/creep and solifluction and minor fluviatile reworking

Further descriptions from the literature are given in the details below.

The thickness of the deposit is very variable. Green et al. indicate that the deposit is at least 3 m thick but do not state whether the base rests on *in situ* chalk. Prestwich and Brown (1855) gave a section at Mr Harding's Brickpit (see below) that shows up to 34 feet (10.36 m) of beds resting on undisturbed chalk. Topographically the surface of the terrace and 'brickearth' are between 51 and 58 m above OD.

[p.186 above]

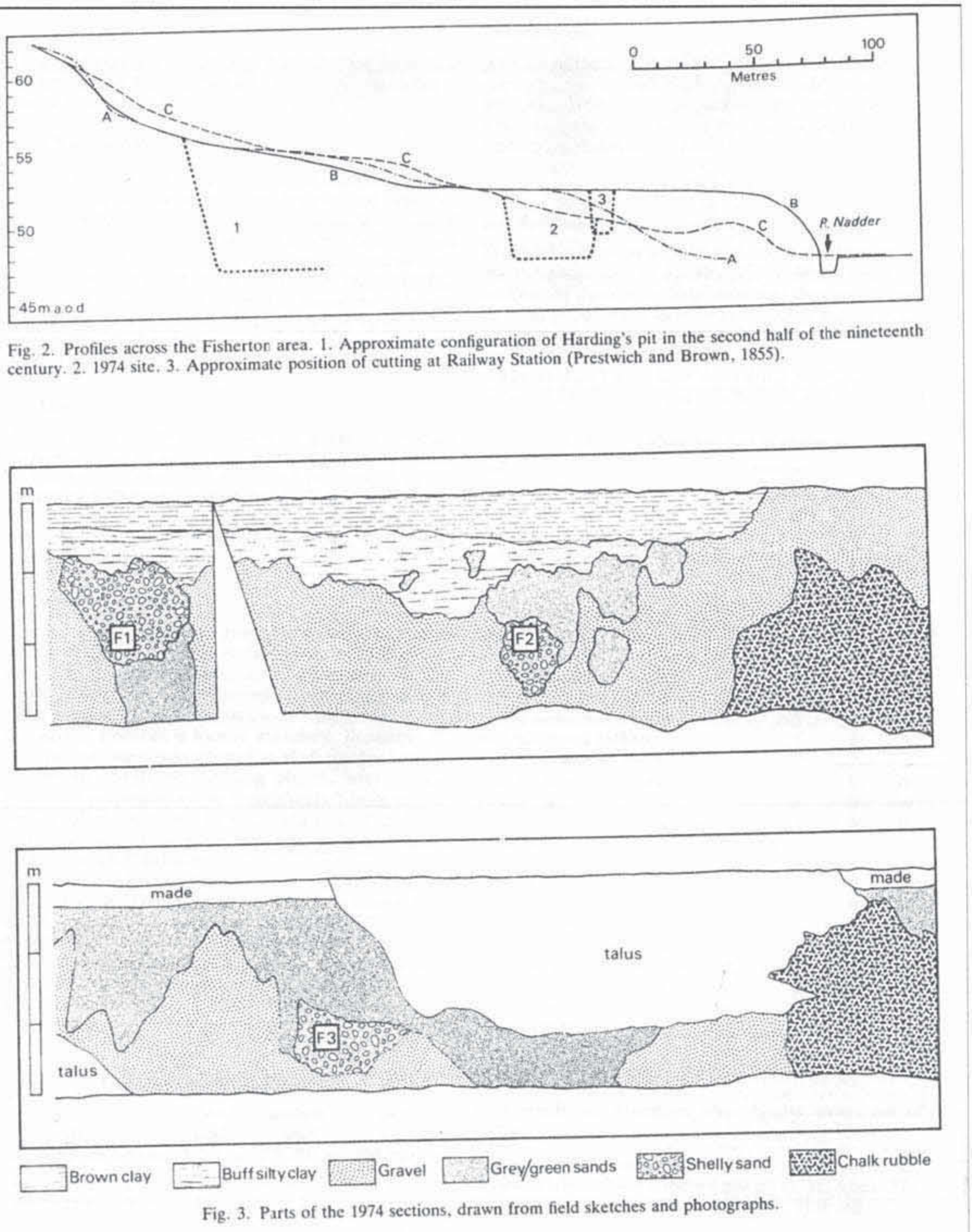


Figure 67: The sediments exposed at temporary sections [SU 138 302] at Fisherton in 1974 (Green et al, 1983, fig. 3)

Details

SU13SW

There are no exposures of this deposit remaining but degraded overgrown faces can still be seen at numerous of the localities mentioned in the literature.

The cutting ENE of Wilton [SU 110 313 or? SU 104 316 or? 101 319] was described in Prestwich and Brown (1855) see tabulated description and Figure 68 below. The description is probably of head on the valley slope, topographically above the level of the 'brickearth', and head is mapped at various localities along this stretch of the line.

[p.187 above]

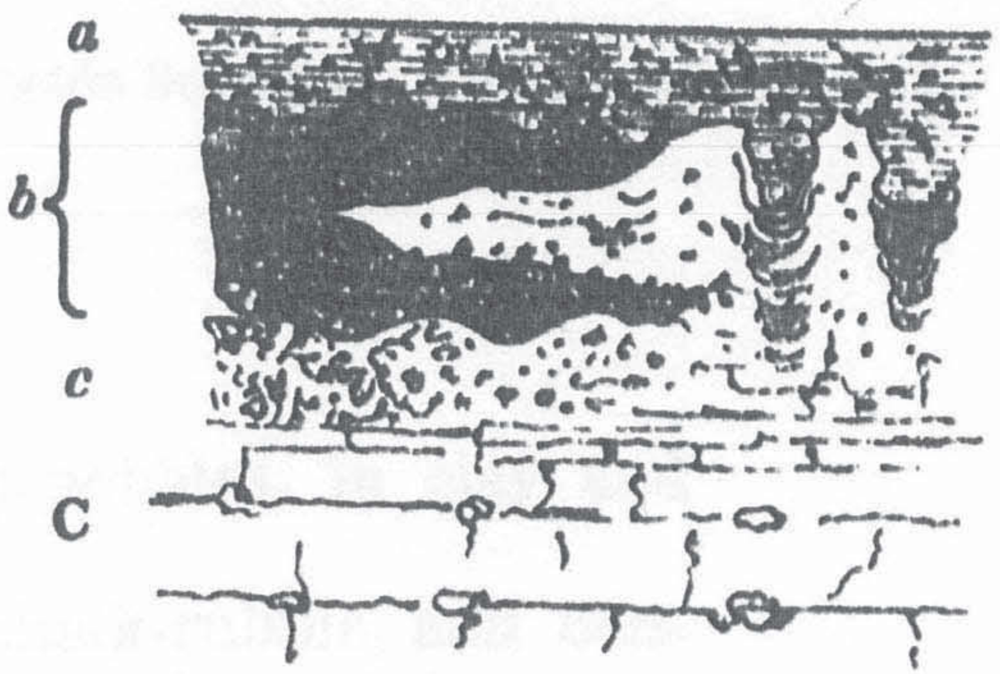


Figure 68: Section in the railway cutting ENE of Wilton (Prestwich and Brown, 1855)

Deposit	Lithology	Thickness m
? 'Brickearth'	a. Brown earth and flints.	0.61 to 0.91
	b. Coarse gravel, consisting chiefly of subangular flints, with pieces of chert, ironstone, sandstone and some flint pebbles, in brown clay more or less sandy.	1.52
Weathered Chalk	c. Chalk rubble, upper portion 'waved; passing laterally into 'b' (a few *Sucineae* and *Helices* are found in this rubble).	2.13
Seaford Chalk Formation	d. Chalk.	unmeasured

The location of the railway cutting in relation to the Wylye Valley is also shown diagrammatically in Figure 73.
Further east Prestwich and Brown (1855) noted another similar occurrence in the "section on the railway beneath the high road near Bemerton" [SU 123 308]. This is again probably a description of valley infill incorporating both slope head and the 'brickearth'. In this case a remnant of the *in situ* 'brickearth' is also present.

Deposit	Lithology	Thickness m
Head	Earth and gravel	0.30
	Gravel, chalk rubble, clay and Brickearth mixed	0.91
	Brickearth, with a few dispersed angular flints and some shells (*Sucineae* and *Helices*).	2.44
	Patch of coarse gravel, as above, with a base of 'brickearth'.	0.30
Brickearth	Brickearth, rendered porous by numerous very fine Serpula-like perforations; only a very few angular flints, and no shells,	3.05

The Harding's Pit (presumed to be the topographically lower of the two located by Delair and Shackley, 1979) at [SU 135 304] is now obliterated (initially by the Hospital and by later developments on the site) is described by Prestwich and Brown (1855) (Figure 69). Their description is tabulated below and shown graphically in Figure 70.

[p.188 above]

Deposit	Lithology	Thickness m
Solifluced material	a. Earth and flint rubble, variable.	0.30 to 0.61
	b. Rubble of angular flints, fragments of chalk, flint pebbles, in clay and brickearth.	1.22 to 1.83
Brickearth	c. Brickearth, mixed with variable masses of flint- and chalk-rubble, and containing bones and a few shell, chiefly in the lower part.	3.05 to 5.49
	d. Light-coloured fine marl, full of well preserved shells, and a few bones.	0.30 to 0.61
Terrace/ Solifluced material	e. Flint- and Chalk-rubble, with sand and clay, only upper surface exposed.	?3.05 to 1.22
Seaford Chalk	f. Chalk	unmeasured

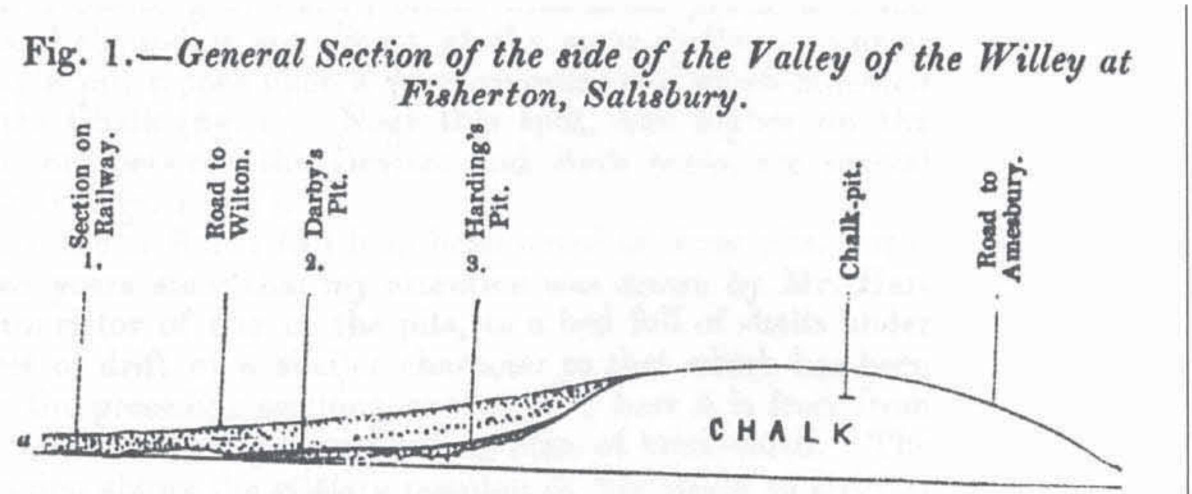


Figure 69: General section of the 'Willey' Valley at Fisherton, Prestwich and Brown (1855)

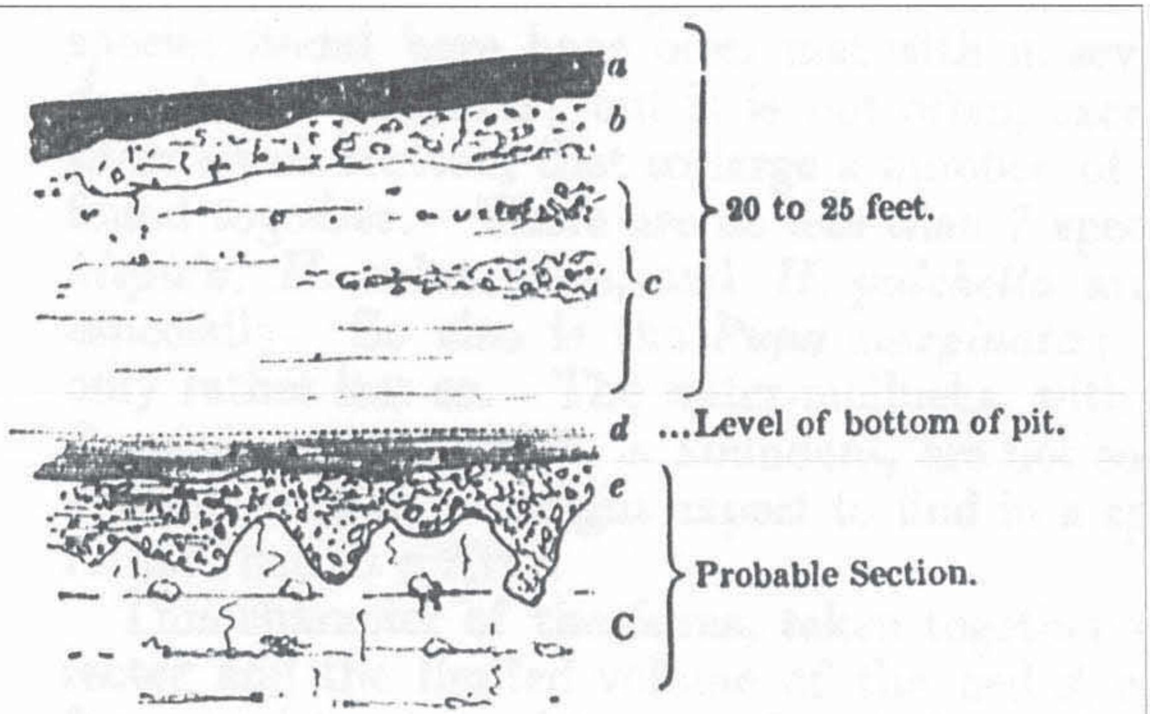


Figure 70: The section at Mr Harding's Brick Pit, Fisherton (Prestwich and Brown, 1855)

8.7 River Terrace Deposits (1 to 9 and Undifferentiated)

[...]

[p.189 above]

[...]

The term river terrace deposits undifferentiated is used within this district to identify gravel spreads on the lower valley slopes that show some crude or degraded terrace surface. It is this generally flat surface that differentiates these deposits from other gravelly slope head deposits but the surface brash may well have the same appearance. The deposits are generally separated from the valley fill by a bedrock bluff that is usually between 15 and 20 m above the floodplain and the gravel flat usually has a slight rise to between 25 and 30 m above the floodplain.

The large outcrop upslope from the 'Fisherton Brickearth' is likely to be a composite of soliflucted material and terrace material. There is a steep bluff, covered in clayey gravelly soils, of some 15 m above the mapped Brickearth that culminates at a marked positive break of slope mirroring the 76 m contour (perhaps also reflecting a thin head deposit over a buried bedrock feature high in the Seaford Chalk Formation). Above this level the soils are much more gravelly on a shallower slope and this may well represent a higher level of terrace material (between 25 and 40 m above the floodplain).

The deposit is mapped on the north flank of the River Nadder around Dinton and Baverstock [SU 014 314 to 034 317], north of Ugford [SU 084 312] and between Wilton and Fisherton. A small outcrop in the grounds of Godolphin School at Milford Hill [SU 152 299] and on the interfluve between the Avon and Bourne valleys, was investigated by Harding and Bridgland (1998). They designated the outcrop as 'Higher Terrace Gravel' at about 30 m above the floodplain and equated it with Terrace 7 of the Avon as classified by Kubala (1980) (therefore terrace 8 utilising the classification adopted on Ringwood to the south). Only one small outcrop was identified south of the River Nadder, at Temple Copse [SU 098 304] on the Wilton Estate. Although designated as undifferentiated because of its isolation its height of about 40 m above the floodplain level would suggest that it may be the most upstream occurrence of the ninth terrace. Descriptions of the gravel from Harding and Bridgland (1998) indicate a mixed lithology with four 'end members' (white chalk debris, white bedded chalky gravel, dark yellow brown clayey gravel and greenish clayey sand) and variations between. They strongly suggest that much of the deposit was originally chalky but has suffered extreme decalcification.

Only the fourth terrace has been identified extensively in the district, and occurs at around 1.5-5m above river level and separated from the alluvial flat be a small bluff. No sections have been seen in this terrace, but field brash consists of abundant well-rounded to subangular and broken flint gravel, with clasts of varying sizes. Some are stained and rubified, and are probably derived from the clay-with-flints. Many outcrops along the margins of the alluvial plain are identified in the Nadder, Wylye, Avon and Ebble valleys. They are best developed within the Wylye/Nadder/Avon confluence area around Wilton and Salisbury (Plates 41 and 42).

[...]

[p.190 above]

University of Gloucestershire

Luminescence dating laboratory

Optical dating of sediments: Highbury Avenue, Salisbury

to

S. Ford

Thames Valley Archaeological Services

Prepared by Dr P.S. Toms, 04 Feb 2014

Contents

Scope of Report

This is a standard report of the Luminescence dating laboratory, University of Gloucestershire. In large part, the document summarises the processes, diagnostics and data drawn upon to deliver Table 1. A conclusion on the analytical validity of each sample's optical age estimate is expressed in Table 2; where there are caveats, the reader is directed to the relevant section of the report that explains the issue further in general terms.

Field Code	Lab Code	Overburden (m)	Grain size (µm)	Moisture content (%)	NaI γ-spectrometry (*in situ*)			γ D_r (Gy.ka^{-1})	Ge γ-spectrometry (*ex situ*)			α D_r (Gy.ka^{-1})	β D_r (Gy.ka^{-1})	Cosmic D_r (Gy.ka^{-1})	Preheat (°C for 10s)	Low Dose Repeat Ratio	Interpolated:Applied Low Regenerative-dose D_e	High Dose Repeat Ratio	Interpolated:Applied High Regenerative-dose D_e	Post-IR OSL Ratio
					K (%)	Th (ppm)	U (ppm)		K (%)	Th (ppm)	U (ppm)									
S1	GL13001	2.8	5-15	12 ± 3	-	-	-	0.62 ± 0.05	0.97 ± 0.06	8.11 ± 0.78	0.88 ± 0.09	0.28 ± 0.03	0.94 ± 0.07	0.13 ± 0.01	280	1.02 ± 0.04	1.06 ± 0.05	1.06 ± 0.03	1.05 ± 0.08	0.90 ± 0.03
S2	GL13002	3.9	125-180	12 ± 3	-	-	-	0.73 ± 0.08	1.27 ± 0.06	7.60 ± 0.50	1.62 ± 0.10	-	1.16 ± 0.11	0.11 ± 0.01	260	1.01 ± 0.02	1.02 ± 0.03	1.01 ± 0.02	1.04 ± 0.04	1.00 ± 0.02

Field Code	Lab Code	Total D_r (Gy.ka^{-1})	D_e (Gy)	Age (ka)
S1	GL13001	1.98 ± 0.10	93.3 ± 15.3	47 ± 8 (3)
S2	GL13002	1.96 ± 0.13	109.4 ± 16.5	56 ± 9 (9)

Table 1 D_r, D_e and Age data of submitted samples located at c. 51°N, 2°W, 55m. Age estimates expressed relative to year of sampling. Uncertainties in age are quoted at 1σ confidence, are based on analytical errors and reflect combined systematic and experimental variability and (in parenthesis) experimental variability alone (see 6.0). Blue indicates samples with accepted age estimates, red, age estimates with caveats (see Table 2).

Generic considerations	Field Code	Lab Code	Sample specific considerations
Absence of *in situ* γ spectrometry data (see section 4.0)	S1	GL13001	None
	S2	GL13002	None

Table 2 Analytical validity of sample suite age estimates and caveats for consideration

1.0 Mechanisms and principles

Upon exposure to ionising radiation, electrons within the crystal lattice of insulating minerals are displaced from their atomic orbits. Whilst this dislocation is momentary for most electrons, a portion of charge is redistributed to meta-stable sites (traps) within the crystal lattice. In the absence of significant optical and thermal stimuli, this charge can be stored for extensive periods. The quantity of charge relocation and storage relates to the magnitude and period of irradiation. When the lattice is optically or thermally stimulated, charge is evicted from traps and may return to a vacant orbit position (hole). Upon recombination with a hole, an electron's energy can be dissipated in the form of light generating crystal luminescence providing a measure of dose absorption.

Herein, quartz is segregated for dating. The utility of this minerogenic dosimeter lies in the stability of its datable signal over the mid to late Quaternary period, predicted through isothermal decay studies (e.g. Smith *et al.*, 1990; retention lifetime 630 Ma at 20℃) and evidenced by optical age estimates concordant with independent chronological controls (e.g. Murray and Olley, 2002). This stability is in contrast to the anomalous fading of comparable signals commonly observed for other ubiquitous sedimentary minerals such as feldspar and zircon (Wintle, 1973; Templer, 1985; Spooner, 1993)

Optical age estimates of sedimentation (Huntley *et al.*, 1985) are premised upon reduction of the minerogenic time dependent signal (Optically Stimulated Luminescence, OSL) to zero through exposure to sunlight and, once buried, signal reformulation by absorption of litho- and cosmogenic radiation. The signal accumulated post burial acts as a dosimeter recording total dose absorption, converting to a chronometer by estimating the rate of dose absorption quantified through the assay of radioactivity in the surrounding lithology and streaming from the cosmos.

$$\text{Age} = \frac{\text{Mean Equivalent Dose } (D_e\text{, Gy})}{\text{Mean Dose Rate } (D_r\text{, Gy.ka}^{-1})}$$

Aitken (1998) and Bøtter-Jensen et al. (2003) offer a detailed review of optical dating.

2.0 Sample Preparation

Two sediment samples were submitted within opaque tubing for Optical dating. To preclude optical erosion of the datable signal prior to measurement, all samples were opened and prepared under controlled laboratory illumination provided by Encapsulite RB-10 (red) filters. To isolate that material potentially exposed to daylight during sampling, sediment located within 20 mm of each tube-end was removed.

The remaining sample was dried and then sieved. Depending upon each samples modal grain size, either fine sand (125-180 μm) or fine silt (5-15 μm) was segregated (Table 1). These fractions were then subjected to acid and alkaline digestion (10% HCl, 15% H_2O_2) to attain removal of carbonate and organic components respectively.

For fine sands, a further acid digestion in HF (40%, 60 mins) was used to etch the outer 10-15 μm layer affected by α radiation and degrade the feldspar content. During HF treatment, continuous magnetic stirring was used to effect isotropic etching of grains. 10% HCl was then added to remove acid soluble fluorides. The sample was dried, resieved and quartz isolated from the remaining heavy mineral fraction using a sodium polytungstate density separation at 2.68g.cm^{-3}. Twelve 8 mm multi-grain aliquots (*c.* 3-6 mg) of quartz were then mounted on aluminium discs for determination of D_e values.

Fine silt sized quartz, along with other mineral grains of varying density and size, was extracted by sample sedimentation in acetone (<15 μm in 2 min 20 s, >5 μm in 21 mins at 20ºC). Feldspars and amorphous silica were then removed from this fraction through acid digestion (35% H_2SiF_6 for 2 weeks, Jackson *et al.*, 1976; Berger *et al.*, 1980). Following addition of 10% HCl to remove acid soluble fluorides, grains degraded to <5 μm as a result of acid treatment were removed by acetone sedimentation. 6 aliquots (ca. 1.5 mg) were then mounted on aluminium discs for D_e evaluation.

All drying was conducted at 40°C to prevent thermal erosion of the signal. All acids and alkalis were Analar grade. All dilutions (removing toxic-corrosive and non-minerogenic luminescence-bearing substances) were conducted with distilled water to prevent signal contamination by extraneous particles.

3.0 Acquisition and accuracy of D_e value

All minerals naturally exhibit marked inter-sample variability in luminescence per unit dose (sensitivity). Therefore, the estimation of D_e acquired since burial requires calibration of the natural signal using known amounts of laboratory dose. D_e values were quantified using a single-aliquot regenerative-dose (SAR) protocol (Murray and Wintle 2000; 2003) facilitated by a Risø TL-DA-15 irradiation-stimulation-detection system (Markey *et al.*, 1997; Bøtter-Jensen *et al.*, 1999). Within this apparatus, optical signal stimulation is provided by an assembly of blue diodes (5 packs of 6 Nichia NSPB500S), filtered to 470±80 nm conveying 15 $mW.cm^{-2}$ using a 3 mm Schott GG420 positioned in front of each diode pack. Infrared (IR) stimulation, provided by 6 IR diodes (Telefunken TSHA 6203) stimulating at 875±80nm delivering ~5 $mW.cm^{-2}$, was used to indicate the presence of contaminant feldspars (Hütt *et al.*, 1988). Stimulated photon emissions from quartz aliquots are in the ultraviolet (UV) range and were filtered from stimulating photons by 7.5 mm HOYA U-340 glass and detected by an EMI 9235QA photomultiplier fitted with a blue-green sensitive bialkali photocathode. Aliquot irradiation was conducted using a 1.48 GBq $^{90}Sr/^{90}Y$ β source calibrated for multi-grain aliquots of each isolated quartz fraction against the 'Hotspot 800' ^{60}Co γ source located at the National Physical Laboratory (NPL), UK.

SAR by definition evaluates D_e through measuring the natural signal (Fig. 1) of a single aliquot and then regenerating that aliquot's signal by using known laboratory doses to enable calibration. For each aliquot, 5 different regenerative-doses were administered so as to image dose response. D_e values for each aliquot were then interpolated, and associated counting and fitting errors calculated, by way of exponential plus linear regression (Fig. 1). Weighted (geometric) mean D_e values were calculated using the central age model outlined by Galbraith *et al.* (1999) and are quoted at 1σ confidence (Table 1). The accuracy with which D_e equates to total absorbed dose and that dose absorbed since burial was assessed. The former can be considered a function of laboratory factors, the latter, one of environmental issues. Diagnostics were deployed to estimate the influence of these factors and criteria instituted to optimise the accuracy of D_e values.

3.1 Laboratory Factors

3.1.1 Feldspar contamination

The propensity of feldspar signals to fade and underestimate age, coupled with their higher sensitivity relative to quartz makes it imperative to quantify feldspar contamination. At room temperature, feldspars generate a signal (IRSL; Fig. 1) upon exposure to IR whereas quartz does not. The signal from feldspars contributing to OSL can be depleted by prior exposure to IR. For all aliquots the contribution of any remaining feldspars was estimated from the OSL IR depletion ratio (Duller, 2003). The influence of IR depletion on the OSL signal can be illustrated by comparing the regenerated post-IR OSL D_e with the applied regenerative-dose (Fig. 5). If the addition to OSL by feldspars is insignificant, then the repeat dose ratio of OSL to post-IR OSL should be statistically consistent with unity (Table 1). If any aliquots do not fulfil this criterion, then the sample age estimate should be accepted tentatively. The source of feldspar contamination is rarely rooted in sample preparation; it predominantly results from the occurrence of feldspars as inclusions within quartz.

3.1.2 Preheating

Preheating aliquots between irradiation and optical stimulation is necessary to ensure comparability between natural and laboratory-induced signals. However, the multiple irradiation and preheating steps that are required to define single-aliquot regenerative-dose response leads to signal sensitisation, rendering calibration of the natural signal inaccurate. The SAR protocol (Murray and Wintle, 2000; 2003) enables this sensitisation to be monitored and corrected using a test dose, here set at 5 Gy preheated to 220°C for 10s, to track signal sensitivity between irradiation-preheat steps. However, the accuracy of sensitisation correction for both natural and laboratory signals can be preheat dependent.

The Dose Recovery test was used to assess the optimal preheat temperature for accurate correction and calibration of the time dependent signal. Dose Recovery (Fig. 2) attempts to quantify the combined effects of thermal transfer and sensitisation on the natural signal, using a precise lab dose to simulate natural dose. The ratio between the applied dose and recovered D_e value should be statistically concordant with unity. For this diagnostic, 6 aliquots were each assigned a 10 s preheat between 180°C and 280°C.

That preheat treatment fulfilling the criterion of accuracy within the Dose Recovery test was selected to generate the final D_e value from a further 12 aliquots. Further thermal treatments, prescribed by Murray and Wintle (2000; 2003), were applied to optimise accuracy and precision. Optical stimulation occurred at 125ºC in order to minimise effects associated with photo-transferred thermoluminescence and maximise signal to noise ratios. Inter-cycle optical stimulation was conducted at 280ºC to minimise recuperation.

3.1.3 Irradiation

For all samples having D_e values in excess of 100 Gy, matters of signal saturation and laboratory irradiation effects are of concern. With regards the former, the rate of signal accumulation generally adheres to a saturating exponential form and it is this that limits the precision and accuracy of D_e values for samples having absorbed large doses. For such samples, the functional range of D_e interpolation by SAR has been verified up to 600 Gy by Pawley *et al*. (2010). Age estimates based on D_e values exceeding this value should be accepted tentatively.

3.1.4 Internal consistency

Quasi-radial plots (*cf* Galbraith, 1990) are used to illustrate inter-aliquot D_e variability for natural, repeat regenerative-dose and post-IR OSL signals (Figs 3 to 5, respectively). D_e values are standardised relative to the central D_e value for natural signals and applied dose for regenerated signals. D_e values are described as overdispersed when >5% lie beyond $\pm 2\sigma$ of the standardising value; resulting from a heterogeneous absorption of burial dose and/or response to the SAR protocol. For multi-grain aliquots, overdispersion of natural signals does not necessarily imply inaccuracy. However where overdispersion is observed for regenerated signals, the efficacy of sensitivity correction may be problematic. Murray and Wintle (2000; 2003) suggest repeat dose ratios (Table 1) offer a measure of SAR protocol success, whereby ratios ranging across 0.9-1.1 are acceptable. However, this variation of repeat dose ratios in the high-dose region can have a significant impact on D_e interpolation. The influence of this effect can be outlined by quantifying the ratio of interpolated to applied regenerative-dose ratio (Table 1, Fig. 4). In this study, where both the repeat dose ratios and interpolated to applied regenerative-dose ratios range across 0.9-1.1, sensitivity-correction is considered effective.

3.2 Environmental factors

3.2.1 Incomplete zeroing

Post-burial OSL signals residual of pre-burial dose absorption can result where pre-burial sunlight exposure is limited in spectrum, intensity and/or period, leading to age overestimation. This effect is particularly acute for material eroded and redeposited sub-aqueously (Olley *et al*., 1998, 1999; Wallinga, 2002) and exposed to a burial dose of <20 Gy (e.g. Olley *et al*., 2004), has some influence in sub-aerial contexts but is rarely of consequence where aerial transport has occurred. Within single-aliquot regenerative-dose optical dating there are two diagnostics of partial resetting (or bleaching); signal analysis (Agersnap-Larsen *et al*., 2000; Bailey *et al*., 2003) and inter-aliquot D_e distribution studies (Murray *et al*., 1995).

Within this study, signal analysis was used to quantify the change in D_e value with respect to optical stimulation time for multi-grain aliquots. This exploits the existence of traps within minerogenic dosimeters that bleach with different efficiency for a given wavelength of light to verify partial bleaching. D_e (t) plots (Fig. 6; Bailey *et al*., 2003) are constructed from separate integrals of signal decay as laboratory optical stimulation progresses. A statistically significant increase in natural D_e (t) is indicative of partial bleaching assuming three conditions are fulfilled. Firstly, that a statistically significant increase in D_e (t) is observed when partial bleaching is simulated within the laboratory. Secondly, that there is no significant rise in D_e (t) when full bleaching is simulated. Finally, there should be no significant augmentation in D_e (t) when zero dose is simulated. Where partial bleaching is detected, the age derived from the sample should be considered a maximum estimate only. However, the utility of signal analysis is strongly dependent upon a samples pre-burial experience of sunlight's spectrum and its residual to post-burial signal ratio. Given in the majority of cases, the spectral exposure history of a deposit is uncertain, the absence of an increase in natural D_e (t) does not necessarily testify to the absence of partial bleaching.

Where requested and feasible, the insensitivities of multi-grain single-aliquot signal analysis may be circumvented by inter-aliquot D_e distribution studies. This analysis uses aliquots of single sand grains to quantify inter-grain D_e distribution. At present, it is contended that asymmetric inter-grain D_e distributions are symptomatic of partial bleaching and/or pedoturbation (Murray *et al*., 1995; Olley *et al*., 1999; Olley *et al*., 2004; Bateman *et al*., 2003). For partial bleaching at least, it is further contended that the D_e acquired during burial is located in the minimum region of such ranges. The mean and breadth of this minimum region is the subject of current debate, as it is additionally influenced by heterogeneity in microdosimetry, variable inter-grain response to SAR and residual to post-burial signal ratios. Presently, the apposite measure of age is that defined by the D_e interval delimited by the minimum and central age models of Galbraith *et al*. (1999).

3.2.2 Pedoturbation

The accuracy of sedimentation ages can further be controlled by post-burial trans-strata grain movements forced by pedo- or cryoturbation. Berger (2003) contends pedogenesis prompts a reduction in the apparent sedimentation age of parent material through bioturbation and illuviation of younger material from above and/or by biological recycling and resetting of the datable signal of surface material. Berger (2003) proposes that the chronological products of this remobilisation are A-horizon age estimates reflecting the cessation of pedogenic activity, Bc/C-horizon ages delimiting the maximum age for the initiation of pedogenesis with estimates obtained from Bt-horizons providing an intermediate age 'close to the age of cessation of soil development'. Singhvi et al. (2001), in contrast, suggest that B and C-horizons closely approximate the age of the parent material, the A-horizon, that of the 'soil forming episode'. At present there is no post-sampling mechanism for the direct detection of and correction for post-burial sediment remobilisation. However, intervals of palaeosol evolution can be delimited by a maximum age derived from parent material and a minimum age obtained from a unit overlying the palaeosol. Inaccuracy forced by cryoturbation may be bidirectional, heaving older material upwards or drawing younger material downwards into the level to be dated. Cryogenic deformation of matrix-supported material is, typically, visible; sampling of such cryogenically-disturbed sediments can be avoided.

4.0 Acquisition and accuracy of D_r value

Lithogenic D_r values were defined through measurement of U, Th and K radionuclide concentration and conversion of these quantities into α, β and γ D_r values (Table 1). α and β contributions were estimated from sub-samples by laboratory-based γ spectrometry using an Ortec GEM-S high purity Ge coaxial detector system, calibrated using certified reference materials supplied by CANMET. γ dose rates can be estimated from *in situ* NaI gamma spectrometry or, where direct measurements are unavailable as in the present case, from laboratory-based Ge γ spectrometry. *In situ* measurements reduce uncertainty relating to potential heterogeneity in the γ dose field surrounding each sample. The level of U disequilibrium was estimated by laboratory-based Ge γ spectrometry. Estimates of radionuclide concentration were converted into D_r values (Adamiec and Aitken, 1998), accounting for D_r modulation forced by grain size (Mejdahl, 1979), present moisture content (Zimmerman, 1971) and, where D_e values were generated from 5-15 µm quartz, reduced signal sensitivity to α radiation (a-value 0.050 ± 0.002; Toms, unpub. data). Cosmogenic D_r values were calculated on the basis of sample depth, geographical position and matrix density (Prescott and Hutton, 1994).

The spatiotemporal validity of D_r values can be considered a function of five variables. Firstly, age estimates devoid of *in situ* γ spectrometry data should be accepted tentatively if the sampled unit is heterogeneous in texture or if the sample is located within 300 mm of strata consisting of differing texture and/or mineralogy. However, where samples are obtained throughout a vertical profile, consistent values of γ D_r based solely on laboratory measurements may evidence the homogeneity of the γ field and hence accuracy of γ D_r values. Secondly, disequilibrium can force temporal instability in U and Th emissions. The impact of this infrequent phenomenon (Olley et al., 1996) upon age estimates is usually insignificant given their associated margins of error. However, for samples where this effect is pronounced (>50% disequilibrium between ^{238}U and ^{226}Ra; Fig. 7), the resulting age estimates should be accepted tentatively. Thirdly, pedogenically-induced variations in matrix composition of B and C-horizons, such as radionuclide and/or mineral remobilisation, may alter the rate of energy emission and/or absorption. If D_r is invariant through a dated profile and samples encompass primary parent material, then element mobility is likely limited in effect. Fourthly, spatiotemporal detractions from present moisture content are difficult to assess directly, requiring knowledge of the magnitude and timing of differing contents. However, the maximum influence of moisture content variations can be delimited by recalculating D_r for minimum (zero) and maximum (saturation) content. Finally, temporal alteration in the thickness of overburden alters cosmic D_r values. Cosmic D_r often forms a negligible portion of total D_r. It is possible to quantify the maximum influence of overburden flux by recalculating D_r for minimum (zero) and maximum (surface sample) cosmic D_r.

5.0 Estimation of Age

Ages reported in Table 1 provide an estimate of sediment burial period based on mean D_e and D_r values and their associated analytical uncertainties. Uncertainty in age estimates is reported as a product of systematic and experimental errors, with the magnitude of experimental errors alone shown in parenthesis (Table 1). Probability distributions indicate the inter-aliquot variability in age (Fig. 8). The maximum influence of temporal variations in D_r forced by minima-maxima in moisture content and overburden thickness is illustrated in Fig. 8. Where uncertainty in these parameters exists this age range may prove instructive, however the combined extremes represented should not be construed as preferred age estimates. The analytical validity of each sample is presented in Table 2.

6.0 Analytical uncertainty

All errors are based upon analytical uncertainty and quoted at 1σ confidence. Error calculations account for the propagation of systematic and/or experimental (random) errors associated with D_e and D_r values.

For D_e values, systematic errors are confined to laboratory β source calibration. Uncertainty in this respect is that combined from the delivery of the calibrating γ dose (1.2%; NPL, pers. comm.), the conversion of this dose for SiO_2 using the respective mass energy-absorption coefficient (2%; Hubbell, 1982) and experimental error, totalling 3.5%. Mass attenuation and bremsstrahlung losses during γ dose delivery are considered negligible. Experimental errors relate to D_e

interpolation using sensitisation corrected dose responses. Natural and regenerated sensitisation corrected dose points (S_i) were quantified by,

$$S_i = (D_i - x.L_i) / (d_i - x.L_i) \qquad \textbf{Eq.1}$$

where D_i = Natural or regenerated OSL, initial 0.2 s

L_i = Background natural or regenerated OSL, final 5 s

d_i = Test dose OSL, initial 0.2 s

x = Scaling factor, 0.08

The error on each signal parameter is based on counting statistics, reflected by the square-root of measured values. The propagation of these errors within Eq. 1 generating σS_i follows the general formula given in Eq. 2. σS_i were then used to define fitting and interpolation errors within exponential plus linear regressions.

For D_r values, systematic errors accommodate uncertainty in radionuclide conversion factors (5%), β attenuation coefficients (5%), a-value (4%; derived from a systematic α source uncertainty of 3.5% and experimental error), matrix density (0.20 $g.cm^{-3}$), vertical thickness of sampled section (specific to sample collection device), saturation moisture content (3%), moisture content attenuation (2%), burial moisture content (25% relative, unless direct evidence exists of the magnitude and period of differing content) and NaI gamma spectrometer calibration (3%). Experimental errors are associated with radionuclide quantification for each sample by NaI and Ge gamma spectrometry.

The propagation of these errors through to age calculation was quantified using the expression,

$$\sigma y\ (\delta y/\delta x) = (\Sigma\ ((\delta y/\delta x_n).\sigma x_n)^2)^{1/2} \qquad \textbf{Eq. 2}$$

where y is a value equivalent to that function comprising terms x_n and where σy and σx_n are associated uncertainties.

Errors on age estimates are presented as combined systematic and experimental errors and experimental errors alone. The former (combined) error should be considered when comparing luminescence ages herein with independent chronometric controls. The latter assumes systematic errors are common to luminescence age estimates generated by means identical to those detailed herein and enable direct comparison with those estimates.

Fig. 1 Signal Calibration

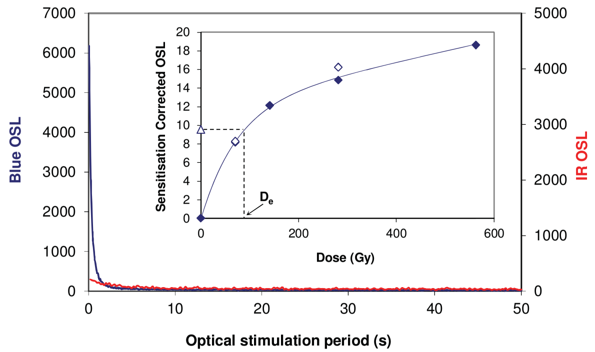


Fig. 1 Signal Calibration Natural blue and laboratory-induced infrared (IR) OSL signals. Detectable IR signal decays are diagnostic of feldspar contamination. Inset, the natural blue OSL signal (open triangle) of each aliquot is calibrated against known laboratory doses to yield equivalent dose (D_e) values. Repeats of low and high doses (open diamonds) illustrate the success of sensitivity correction.

Fig. 2 Dose Recovery The acquisition of D_e values is necessarily predicated upon thermal treatment of aliquots succeeding environmental and laboratory irradiation. The Dose Recovery test quantifies the combined effects of thermal transfer and sensitisation on the natural signal using a precise lab dose to simulate natural dose. Based on this an appropriate thermal treatment is selected to generate the final D_e value.

Fig. 3 Inter-aliquot D_e distribution Provides a measure of inter-aliquot statistical concordance in D_e values derived from **natural** irradiation. Discordant data (those points lying beyond **±2 standardised ln D_e**) reflects heterogeneous dose absorption and/or inaccuracies in calibration.

Fig. 4 Low and High Repeat Regenerative-doses Measures the statistical concordance of D_e from **low** and **high** repeat regenerative-doses with the applied regenerative-dose. Discordant data (those points lying beyond **±2 ln D_e** standardised against the applied regenerative-dose) indicate a significant impact of uncorrected sensitisation upon dose response and D_e interpolation.

Fig. 5 OSL to Post-IR OSL Measures the statistical concordance of post-IR OSL D_e with the applied regenerative-dose. Discordant, underestimating data (those points lying below **-2 ln D_e** standardised against the applied regenerative-dose) coupled with an IRSL signal (Fig. 1) highlight the presence of significant feldspar contamination.

Fig. 6 Signal Analysis Statistically significant increase in **natural** D_e value with signal stimulation period is indicative of a partially-bleached signal, provided a significant increase in D_e results from **simulated partial bleaching** followed by insignificant adjustment in D_e for simulated **zero** and **full bleach** conditions. Ages from such samples are considered maximum estimates. In the absence of a significant rise in D_e with stimulation time, simulated partial bleaching and zero/full bleach tests are not assessed.

Fig. 7 U Activity Statistical concordance (equilibrium) in the activities of the daughter radioisotope ^{226}Ra with its parent ^{238}U may signify the temporal stability of D_r emissions from these chains. Significant differences (disequilibrium; >50%) in activity indicate addition or removal of isotopes creating a time-dependent shift in D_r values and increased uncertainty in the accuracy of age estimates. A 20% disequilibrium marker is also shown.

Fig. 8 Age Range The **mean age range** provides an estimate of sediment burial period based on mean D_e and D_r values with associated analytical uncertainties. The probability distribution indicates the inter-aliquot variability in age. The **maximum influence** of temporal variations in D_r forced by minima-maxima variation in moisture content and overburden thickness may prove instructive where there is uncertainty in these parameters, however the combined extremes represented should not be construed as preferred age estimates.

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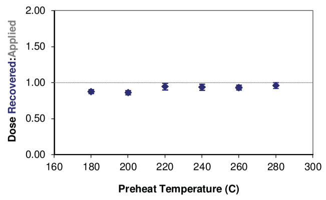


Fig. 3 Inter-aliquot D_e distribution

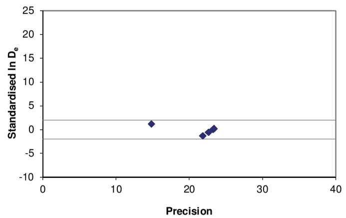


Fig. 4 Low and High Repeat Regenerative-doses

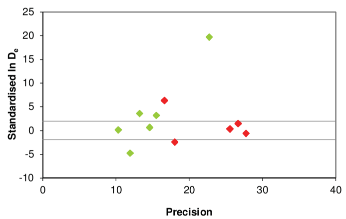
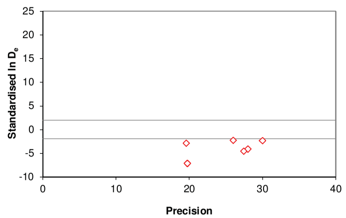


Fig. 5 Post-IR OSL



Sample: GL13001

Fig. 6 Signal Analysis

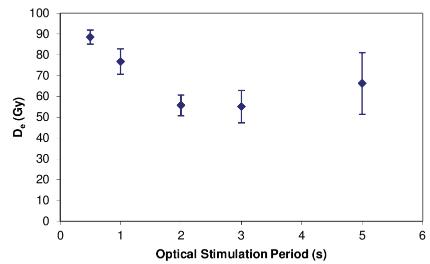


Fig. 7 U Decay Activity

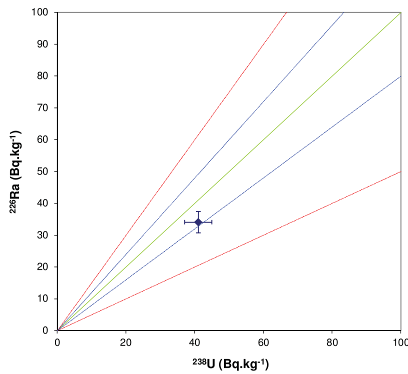
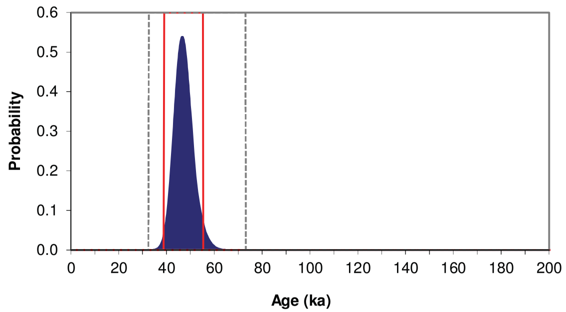


Fig. 8 Age Range



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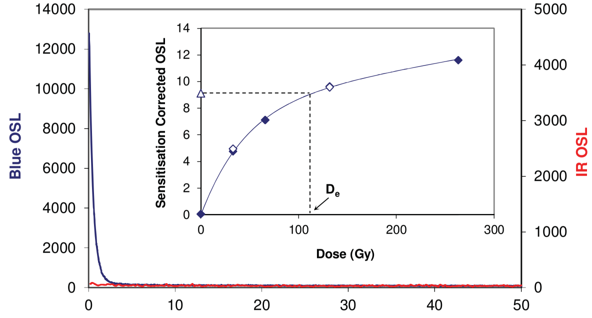

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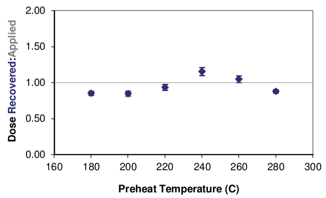


Fig. 3 Inter-aliquot D_e distribution

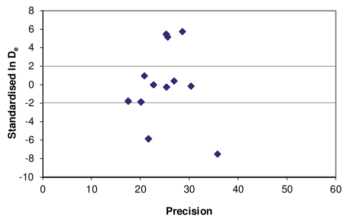


Fig. 4 Low and High Repeat Regenerative-doses

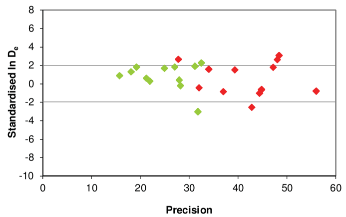
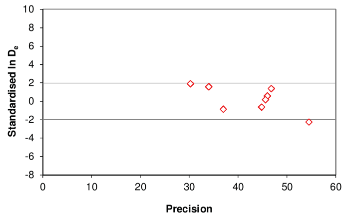


Fig. 5 Post-IR OSL



Sample: GL13002

Fig. 6 Signal Analysis

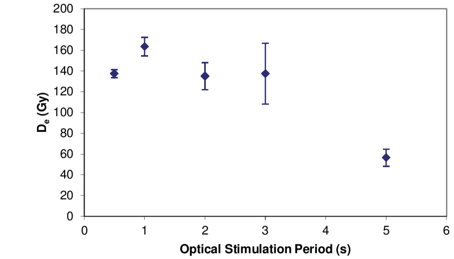


Fig. 7 U Decay Activity

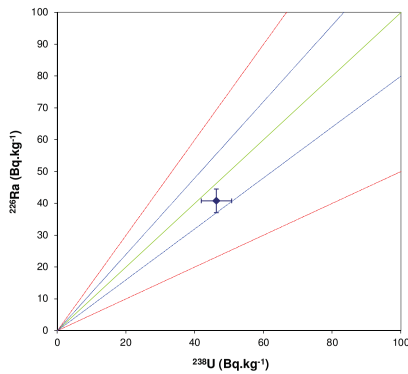
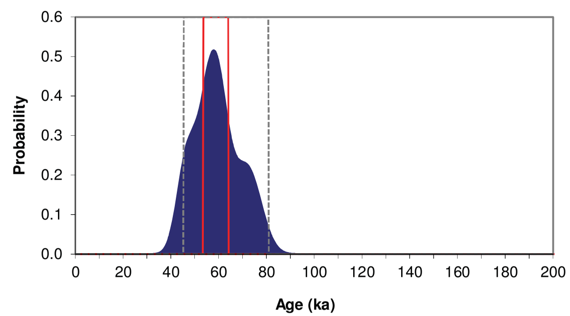


Fig. 8 Age Range



References

Adamiec, G. and Aitken, M.J. (1998) Dose-rate conversion factors: new data. *Ancient TL*, 16, 37-50.

Agersnap-Larsen, N., Bulur, E., Bøtter-Jensen, L. and McKeever, S.W.S. (2000) Use of the LM-OSL technique for the detection of partial bleaching in quartz. *Radiation Measurements*, 32, 419-425.

Aitken, M. J. (1998) An introduction to optical dating: the dating of Quaternary sediments by the use of photon-stimulated luminescence. Oxford University Press.

Bailey, R.M., Singarayer, J.S. , Ward, S. and Stokes, S. (2003) Identification of partial resetting using D_e as a function of illumination time. *Radiation Measurements*, 37, 511-518.

Bateman, M.D., Frederick, C.D., Jaiswal, M.K., Singhvi, A.K. (2003) Investigations into the potential effects of pedoturbation on luminescence dating. *Quaternary Science Reviews*, 22, 1169-1176.

Berger, G.W. (2003). Luminescence chronology of late Pleistocene loess-paleosol and tephra sequences near Fairbanks, Alaska. *Quaternary Research*, 60, 70-83.

Berger, G.W., Mulhern, P.J. and Huntley, D.J. (1980). Isolation of silt-sized quartz from sediments. *Ancient TL*, 11, 147-152.

Bøtter-Jensen, L., Mejdahl, V. and Murray, A.S. (1999) New light on OSL. *Quaternary Science Reviews*, 18, 303-310.

Bøtter-Jensen, L., McKeever, S.W.S. and Wintle, A.G. (2003) Optically Stimulated Luminescence Dosimetry. Elsevier, Amsterdam.

Duller, G.A.T (2003) Distinguishing quartz and feldspar in single grain luminescence measurements. *Radiation Measurements*, 37, 161-165.

Galbraith, R, F. (1990) The radial plot: graphical assessment of spread in ages. *Nuclear Tracks and Radiation Measurements*, 17, 207-214.

Galbraith, R. F., Roberts, R. G., Laslett, G. M., Yoshida, H. and Olley, J. M. (1999) Optical dating of single and multiple grains of quartz from Jinmium rock shelter (northern Australia): Part I, Experimental design and statistical models. *Archaeometry*, 41, 339-364.

Huntley, D.J., Godfrey-Smith, D.I. and Thewalt, M.L.W. (1985) Optical dating of sediments. *Nature*, 313, 105-107.

Hubbell, J.H. (1982) Photon mass attenuation and energy-absorption coefficients from 1keV to 20MeV. *International Journal of Applied Radioisotopes*, 33, 1269-1290.

Hütt, G., Jaek, I. and Tchonka, J. (1988) Optical dating: K-feldspars optical response stimulation spectra. *Quaternary Science Reviews*, 7, 381-386.

Jackson, M.L., Sayin, M. and Clayton, R.N. (1976). Hexafluorosilicic acid regent modification for quartz isolation. *Soil Science Society of America Journal*, 40, 958-960.

Markey, B.G., Bøtter-Jensen, L., and Duller, G.A.T. (1997) A new flexible system for measuring thermally and optically stimulated luminescence. *Radiation Measurements*, 27, 83-89.

Mejdahl, V. (1979) Thermoluminescence dating: beta-dose attenuation in quartz grains. *Archaeometry*, 21, 61-72.

Murray, A.S. and Olley, J.M. (2002) Precision and accuracy in the Optically Stimulated Luminescence dating of sedimentary quartz: a status review. *Geochronometria*, 21, 1-16.

Murray, A.S. and Wintle, A.G. (2000) Luminescence dating of quartz using an improved single-aliquot regenerative-dose protocol. *Radiation Measurements*, 32, 57-73.

Murray, A.S. and Wintle, A.G. (2003) The single aliquot regenerative dose protocol: potential for improvements in reliability*. Radiation Measurements*, 37, 377-381.

Murray, A.S., Olley, J.M. and Caitcheon, G.G. (1995) Measurement of equivalent doses in quartz from contemporary water-lain sediments using optically stimulated luminescence*. Quaternary Science Reviews*, 14, 365-371.

Olley, J.M., Murray, A.S. and Roberts, R.G. (1996) The effects of disequilibria in the Uranium and Thorium decay chains on burial dose rates in fluvial sediments. *Quaternary Science Reviews*, 15, 751-760.

Olley, J.M., Caitcheon, G.G. and Murray, A.S. (1998) The distribution of apparent dose as determined by optically stimulated luminescence in small aliquots of fluvial quartz: implications for dating young sediments. *Quaternary Science Reviews*, 17, 1033-1040.

Olley, J.M., Caitcheon, G.G. and Roberts R.G. (1999) The origin of dose distributions in fluvial sediments, and the prospect of dating single grains from fluvial deposits using -optically stimulated luminescence. *Radiation Measurements,* 30**,** 207-217.

Olley, J.M., Pietsch, T. and Roberts, R.G. (2004) Optical dating of Holocene sediments from a variety of geomorphic settings using single grains of quartz. *Geomorphology*, 60, 337-358.

Pawley, S.M., Toms, P.S., Armitage, S.J., Rose, J. (2010) Quartz luminescence dating of Anglian Stage fluvial sediments: Comparison of SAR age estimates to the terrace chronology of the Middle Thames valley, UK. *Quaternary Geochronology*, 5, 569-582.

Prescott, J.R. and Hutton, J.T. (1994) Cosmic ray contributions to dose rates for luminescence and ESR dating: large depths and long-term time variations. *Radiation Measurements*, 23, 497-500.

Singhvi, A.K., Bluszcz, A.., Bateman, M.D., Someshwar Rao, M. (2001). Luminescence dating of loess-palaeosol sequences and coversands: methodological aspects and palaeoclimatic implications. *Earth Science Reviews*, 54, 193-211.

Smith, B.W., Rhodes, E.J., Stokes, S., Spooner, N.A. (1990) The optical dating of sediments using quartz. *Radiation Protection Dosimetry*, 34, 75-78.

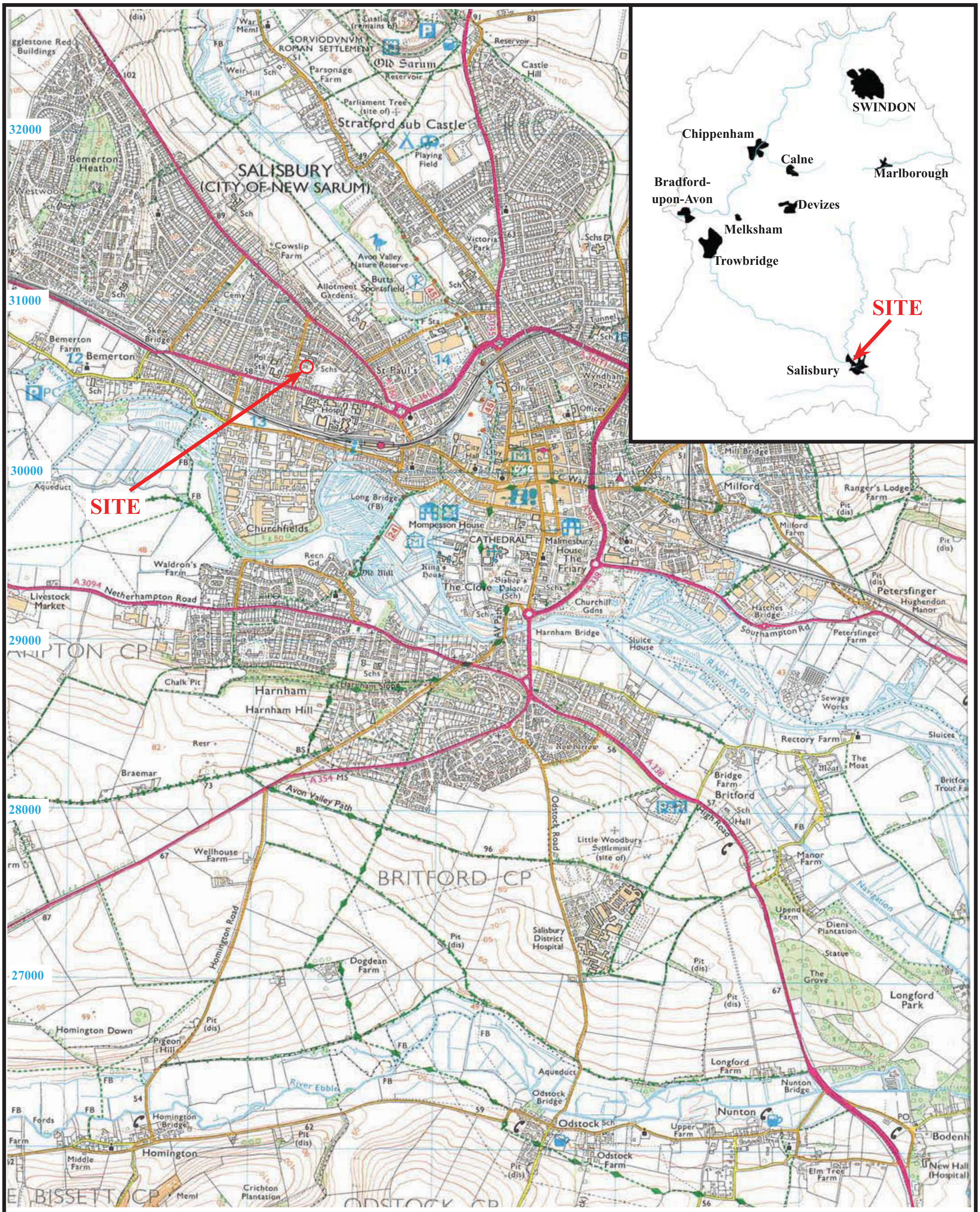
Spooner, N.A. (1993) The validity of optical dating based on feldspar. Unpublished D.Phil. thesis, Oxford University.

Templer, R.H. (1985) The removal of anomalous fading in zircons. *Nuclear Tracks and Radiation Measurements*, 10, 531-537.

Wallinga, J. (2002) Optically stimulated luminescence dating of fluvial deposits: a review. *Boreas* 31, 303-322.

Wintle, A.G. (1973) Anomalous fading of thermoluminescence in mineral samples. *Nature*, 245, 143-144.

Zimmerman, D. W. (1971) Thermoluminescent dating using fine grains from pottery. *Archaeometry*, 13, 29-52.



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Former Highbury and Fisherton Manor Schools, Highbury Avenue, Salisbury, Wiltshire
Palaeolithic Test Pit

Figure 1. Location of site within Salisbury and Wiltshire.

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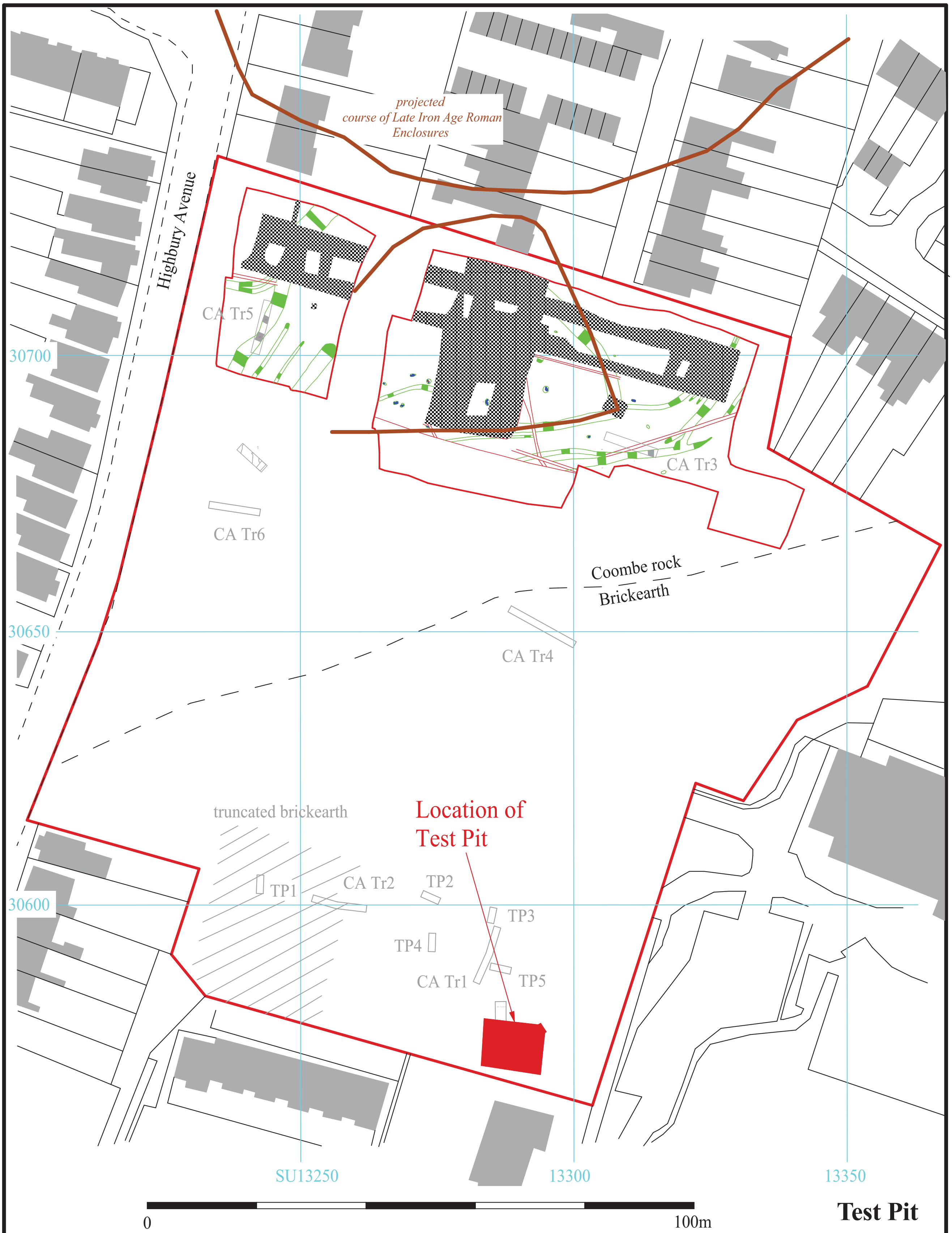

Former Highbury and Fisherton Manor Schools, Highbury Avenue, Salisbury, Wiltshire 2013
Quaternary Geology Test Pit

Figure 2. Location of excavation.

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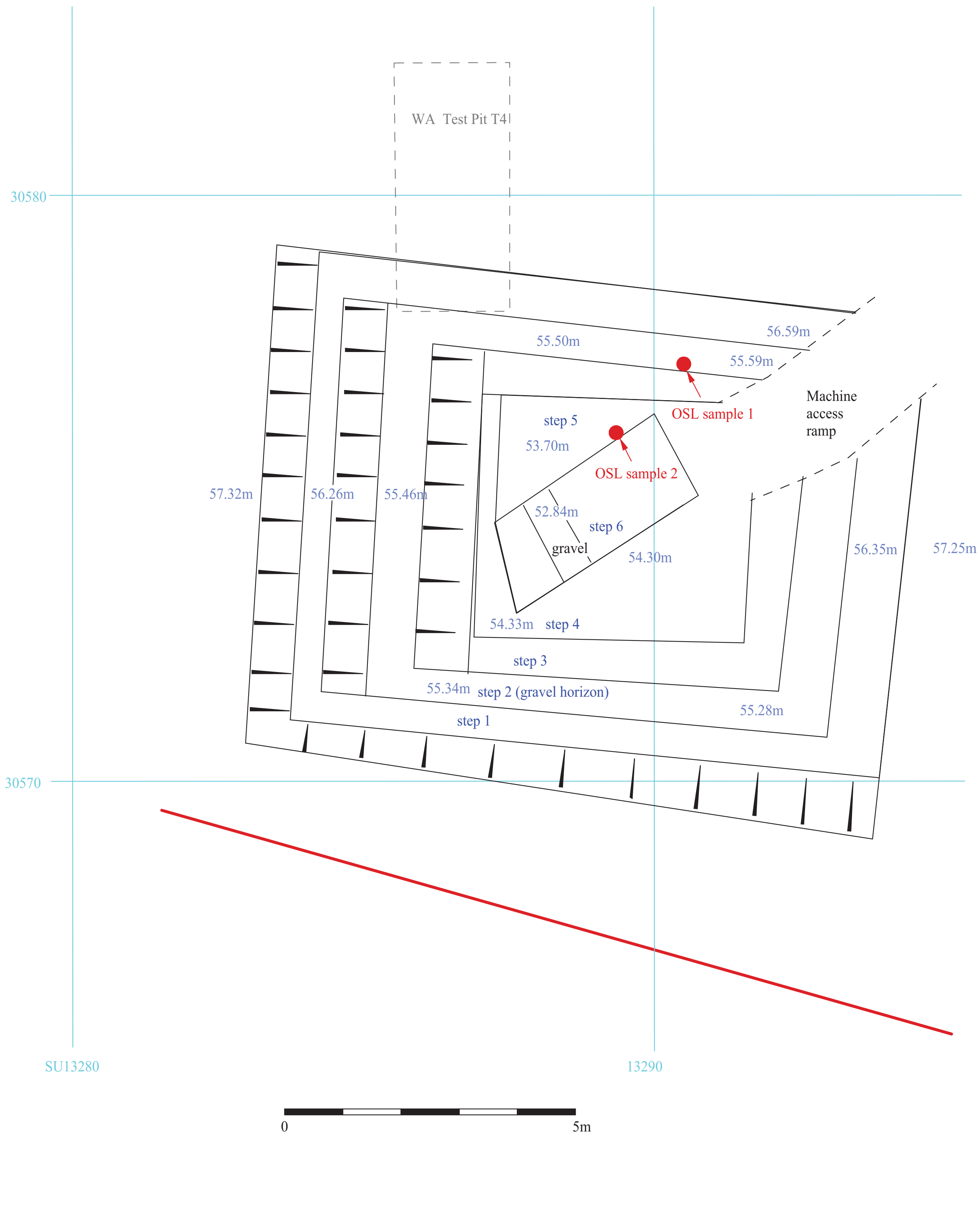

Former Highbury and Fisherton Manor Schools, Highbury Avenue, Salisbury, Wiltshire 2013
Quaternary Geology Test Pit

Figure 3. Detailed plan of test pit.

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Plate 1, View of test pit during inital phases of excavation, looking north east, Scales: 2m and 1m

Plate 2, View of test pit after excavation, looking north west, Scales: 2m and 1m

Plate 3, View of upper test pit after excavation, looking north west, Scales: 2m

Plate 4, View of lower test pit after excavation, looking south, Scale: 1m

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Former Highbury and Fisherton Manor Schools, Highbury Avenue, Salisbury, Wiltshire
Palaeolithic Test Pit
Plates 1-4

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TIME CHART

	Calendar Years
Modern	AD 1901
Victorian	AD 1837
Post Medieval	AD 1500
Medieval	AD 1066
Saxon	AD 410
Roman	AD 43
	BC/AD
Iron Age	750 BC
Bronze Age: Late	1300 BC
Bronze Age: Middle	1700 BC
Bronze Age: Early	2100 BC
Neolithic: Late	3300 BC
Neolithic: Early	4300 BC
Mesolithic: Late	6000 BC
Mesolithic: Early	10000 BC
Palaeolithic: Upper	30000 BC
Palaeolithic: Middle	70000 BC
Palaeolithic: Lower	2,000,000 BC
↓	↓

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