THE PALAEOLITHIC RIVERS OF SOUTH-WEST BRITAIN

(PNUM 3847)

Fieldwork Report (Phase II)

Prepared for

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by

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1. Introduction

This report is purely on the fieldwork component of Phase 2 of the Palaeolithic Rivers of South West Britain Project.

2. Summary of Fieldwork Objectives and Progress

All the fieldwork aims as outlined in the Phase 2 project design have been successfully completed within the allotted timeframe. The core fieldwork objectives in Phase 2 were to:

- Conduct extensive mapping, sampling and dating of the Exe, Otter and Axe valley systems including initial calibration of techniques in the Axe valley. This work has been successfully completed in all three areas.
- Conduct targeted monitoring, sampling and dating (where appropriate) of fluvial sedimentary exposures in other parts of the south-west region as opportunities arise. This work has been successfully completed.
- Complete a desktop evaluation of the Axe system using IFSAR and GIS methodologies. This evaluation has been successfully completed, and its refinement will be important in producing the final synthesis of the Lower and Middle Palaeolithic occupation of the south-west.
- Enhance the county HERs and develop the existing GIS model resources and disseminate the information to the HERs. An interim enhancement was completed and discussed with the HERs at the Phase 2 workshop (July 2006). This is discussed further under Section 9 below.
3. Fieldwork Summary: River Exe

3.1 Background
Following the phase one evaluation, the most pertinent points regarding the Exe terraces may be summarised as follows:

- Eight terraces have been differentiated in association with the Exe (Scrivener, 1984).
- Palaeolithic archaeological artefacts have been found in direct association with terrace 5.
- The higher-level terraces appear to drape over the landscape and it has been suggested by Dr R. Scrivener that this is related to periglacial outwash (Scrivener, 1984 and pers. comm. to Laura Basell (LSB)).
- There is altitudinal separation between the terraces.
- There are OSL dates on the terrace 3 deposits at:
  - Five Fords, River Culm (Exe tributary): 39,450 ± 2,930 BP (unpublished work conducted by Prof Tony Brown).
  - Washfield, River Exe: 27,500 ± 240 BP (work conducted by J. Bennett as part of her unpublished PhD research).
- There are very few exposures of any of the terraces, and particularly the higher-level terraces.
- No sedimentological studies have been conducted on them.

During Phase 2, fieldwork has been completed at 3 separate terrace locations in the Exe Valley.
3.2 Princesshay: Terrace 6

This site lies in the centre of Exeter, and is the location of a major development (Grid Reference 292229 092760, Figure 3). Prior to construction, Exeter Archaeology conducted extensive excavations, during which exposures of superficial geology (river terrace 6) and bedrock geology (Whipton Formation and Basalt) were revealed. According to the site geologist, D. Jordon of Terranova, the bedrock geology slopes gently south west (i.e. slopes towards the present-day course of the Exe). The river terrace deposits exposed at the site occurred at heights of between 40 and 42 m OD. Unfortunately some of the best exposures of terrace deposits at this site occurred during the break between Phases 1 & 2 of the Palaeolithic Rivers of South-West Britain project and were buried again by the time Phase 2 began.

Exeter Archaeology took two slides of these exposures, and noted the extent of the gravel spreads, but no little further detail on them (Figure 4). Copies of the slides, plans and grid references were received only last week. According to information from Exeter Archaeology there was a considerable difference between the exposure in the east of the site and the west of the site (C. Barnes, pers. comm. to LSB). In the former the clasts were quite small (~10 cm), appearing as in thin spreads over the site and surviving only in hollows. In the latter, they were larger (up to ~20 cm) and the deposits exposed were deeper and survived as a more general spread. Small exposures of gravel were still visible in November 2005 when LSB visited the site (Figure 2 & Figure 3). These were in the central section of the area shaded yellow on Figure 4. No exposure was greater than 1m in depth, because the river terrace deposits have been truncated by later human activity.

Some shallower deposits were accessible, and these have been recorded through drawings and digital photographs. The best exposure was in a pit interpreted as a night soil pit (Figure 7). The pit fill contained finds of Saxon (597–1066 AD) affinities, providing a minimum age for the pit cut. All exposures exhibited significant cryoturbation and the small clast size of ~10 cm is in keeping with the easterly exposures noted by C. Barnes. A sand deposit, related to the terrace was sampled for OSL dating by Dr Phil Toms (PT). At the time of sampling it was interpreted as being re-worked Whipton formation and this remains the most likely interpretation. Preliminary dates are surprisingly recent: 43000 ± 5000 BP and 44000 ± 4000 BP. These dates probably reflect disturbance of the deposit through cryoturbation during Oxygen Isotope Stage (OIS) 3, rather than the age of terrace deposition. This nevertheless gives us a minimum age of deposition and of any artefacts from within this deposit.

A further briefly exposed section not far from the Civic Centre was logged by C. Barnes (pers. comm. to LSB). This describes an exposure to the north east of the dated site examined by LSB. The top of the gravel had again been truncated, but an exposure of river gravels was revealed to a depth of 1.10 m with a band of manganese staining at the base. The log describes sub-horizontally bedded gravels with some variation in the roundedness of the clasts and matrix, but no mention of cryoturbation features. This does not necessarily mean they were not there, but is in keeping with the findings at Yellowford Farm (see below) where the upper part of the terrace deposits were cryoturbated, but lower deposits did not exhibit any cryoturbation features. Clarification of whether there were any cryoturbation features at the second Princesshay site, and a height OD for this site has been requested. As all the exposures have been truncated, some caution must be exercised. However, a preliminary interpretation (which is dependent on the comparative heights OD) could be that the thinner more westerly spreads of heavily cryoturbated gravel represent the margins of a deeper channel, which is represented by the thicker, more easterly deposits of crudely bedded material. It is probable that similarly cryoturbated deposits once formed the top of the easterly material, but that later anthropogenic processes have truncated these.

That the River Terrace 6 has been reworked through cryoturbation has important implications for the archaeology found within terrace 6, and other terraces pre-dating OIS 3 elsewhere in the Exe Catchment. If the river gravels are being reworked by freeze thaw processes, then artefacts already
within the deposit could also become reworked, and potentially more recent artefacts that were lying on the surface could become incorporated.

Figure 3: Location of Princesshay Development, Exeter. Figure created in ArcGIS by L. Basell.
Figure 4: Location of specific gravel spreads at the Princesshay Development, Exeter courtesy of Exeter Archaeology. Yellow areas in area B/C were examined by LSB in November 2005. Blue area marked “Here” represents exposure recently logged by C. Barnes. Pink is Basalt.

Figure 5: Princesshay excavations, November 2005. © L Basell.

Figure 6: Princesshay excavations, November 2005. © L Basell.

Figure 7: Pit with truncated river gravels exposed. Arrow shows location in deposit underlying river gravel that was sampled for dating purposes. Below that is Whipton Formation solid geology. November 2005. © L Basell.

3.3 Yellowford Farm: Terrace 6
After examining several possible locations, a large area mapped as terrace 6 associated with the River Exe was identified as a suitable target for further investigation. This lies to the north of
Exeter, between the villages of Brampford Speke and Thorverton (Grid Reference 292573 100491). Permission was gained from the landowner (Mr John Day of Yellowford Farm) to excavate large trench by mechanical excavator into Terrace 6. A local mechanical excavator and operator were found. Ground Penetrating Radar was conducted prior to excavation, but due to technical difficulties with the GPR display following the use of the kit by people other than the usual operator, and then equipment failure, results were not successful in this instance. The equipment problems were later resolved and transects were conducted as outlined in the Phase 2 design at Broom (Axe Valley, described below), and (in addition to the original proposal) at Monkey Lane (Otter Valley described below).

Following the excavation of a 20 m trench (Figure 8), clast analysis was conducted on selected units within the gravels; samples were taken for organics; and clasts were taken to BGS for lithological identification. Dr R. Scrivener and Dr B. Leveridge of BGS also visited the excavation. A photographic archive was compiled and sand units from three separate locations were sampled for OSL dating. The site was backfilled, and is now under crop.

In contrast to Princesshay the river terrace deposits here were not truncated and were in fact more substantial than expected. Rather than the very thin drape of gravel anticipated by Dr R. Scrivener, thought to be associated with periglacial outwash (Hosfield et al., 2005: 26), roughly 3.5 m of gravel were discovered beneath a variable amount of topsoil, but generally ~35-45 cm. Whilst these gravels may still represent periglacial outwash, the depth of deposit is greater than previously thought. Most of the gravels were clearly cryoturbated (in concordance with the Princesshay deposits) with the exception of gravels in the deepest part of the pit. An ice-wedge cast was also revealed in two sections at 90° angles to each other (Figure 10). The regularity of the feature, the nature of the deposit, and the fact it appeared in both sections supports this interpretation over it being a root or burrow feature. The depth of the cryoturbation in the exposure at Yellowford indicates the deposit has probably been repeatedly cryoturbated over several different glacial cycles and implies a significant antiquity for the deposit.

The clast analyses data were entered into Excel, and then GeoOrient software was used to generate stereographic plots of these data. The plots very clearly distinguish the heavily cryoturbated area from less cryoturbated areas (See plots in A1.1). Where there is less cryoturbation, clustering is coarse, but clear, possibly giving some indication of palaeoflow directions. Some clasts were up to ~30 cm in size, demonstrating the river that deposited the gravels was at least intermittently high energy. The rock types represented include material derived from Exmoor (BGS staff pers. comm. to LSB) and probably from the Hangman Formation. Ternary Sneed and Folk diagrams, generated using Triplot, have also been completed for Yellowford to allow comparison of clast shapes within the terrace unit, and between terraces of specific catchments. As clast shape is related both to fluvial and taphonomic processes and to lithology, this can be used to identify/clarify major differences between units. For example, at Yellowford the diagrams show a slight variation between the two units on which clast analysis was conducted with the very heavily cryoturbated unit showing a clasts to be more elongate (slab/rod) rather than blocky. This may be related to frost shatter. As the sample size is small, this is only a suggestion but it supports the interpretations of other data, and observations made in the field. Cursory comparison of the Yellowford and Fortescue ternary plots of clast shape, do not show any major differences.

OSL samples were taken from three areas. Due to the lack of large sand lenses in the gravel, two features apparently associated with, but considered during fieldwork to post date the gravels were sampled. A further small sample from an uncryoturbated unit at the very base of the gravels was also taken. The preliminary dates received are 15000 ± 3000 and 12000 ± 2000 on features sampled that cut into the gravels, and 78000 ± 23000 on the small sample taken from the uncryoturbated area at the base of excavation (Figure 9). This latter date is interesting as it is far more recent than we expected and the error margins are extremely large. This means the date could range from OIS 5 to
3, and Phil Toms believes this is a minimum estimate. He wrote (pers. comm. to LSB): “Both the accuracy and precision of this sample's age estimate are influenced by two factors. First, the age is based on a limited number of measurements owing to a low mass of datable material. Second, the Shute sandstone may have some influence on the spatial heterogeneity (accounting for age imprecision) and temporal stability of dose rate (accounting for age underestimation through gradual migration towards the sample of relatively high radioactive U and Th bearing material sourced from the Shute sandstone)”. This is important as, as it demonstrates a methodological limitation of OSL in certain areas of the Exe catchment.

Figure 8: 20 metre trench at Yellowford Farm, view to west. © L Basell.

Figure 9: Basal, non-cryoturbated unit suitable for OSL dating at Yellowford Farm. © L Basell.
3.4 Fortescue Farm: Terrace 4
This site lies close to Brampford Speke (the location of some of the Phase 1 fieldwork) and Yellowford Farm. Its grid reference is 292875 099298 and a good exposure of terrace 4 exists here (Figure 11). Permission was gained from the landowner to clean back a section by hand and log the exposure. In one area further excavation was undertaken by hand in an attempt to reveal the junction between the terrace deposit and bedrock and ascertain the total river terrace deposit thickness. The junction was not revealed, but a further exposure of Terrace 4 section just downstream at Brampford Speke surveyed during Phase 1 shows the gravel thickness to be ~4 m. The total depth of exposed section at Fortescue was 3.7 m and ~3.3 m of this were river terrace deposits. The base of the gravels was not reached, but several distinct units were logged and digitisation of the logs is underway. The section was logged at ~3 m intervals along a well-exposed section of ~20 m. These varied between cryoturbated, chaotically orientated gravels, and sub-horizontally bedded units with no clear evidence of cryoturbation. This suggests that like Yellowford, the river terrace deposits have undergone repeated cryoturbation over different glacial stages. Clast analysis was completed on all the major units. Bulk samples taken for OSL dating have been prepared and will be processed as soon as the machine is free, but the “shilletty” nature of the matrix means the dating may be problematic (PT pers. comm. to LSB & Prof T. Brown (AGB)). The altitudinal separation of this terrace (see Figure 12) suggests that it is associated with a major climatic event, and given the dates already known from Terrace 3 this is likely to be OIS 4.

Clasts were again taken to BGS for lithological identification and, as for terrace 6 at Yellowford, include material derived from the Hangman Formation or the Pickwell Down Sandstone on Exmoor (Dr B. Leveridge pers. comm. to LSB). Their shape as expressed in the Sneed and Folk ternary diagrams, does not differ significantly from those measured at Yellowford either. Of particular interest however is the very clear increase in the roundedness of the clasts between the terrace 6 at Yellowford, and terrace 4 deposits at Fortescue from “Sub Rounded” being dominant at Yellowford, to “Rounded” being dominant at Fortescue in all units. In addition there is nearly a 40% reduction in clast size between terraces when clast sizes across all units (at each terrace respectively) are considered (See A4). These patterns could be interpreted as representing changes in fluvial processes. However, in combination and given that the lithology is the same, an equally valid interpretation is that the terrace 6 deposits have been reworked probably into terrace 5 and then again into terrace 4. This concept has important implications at a more general level for our understanding of terrace formation; particularly as this reworking is a factor that is not expressly incorporated in the Bridgland’s widely used model of terrace formation (Bridgland 2000). Stereograph plots of clast dip and orientation from all the units at Fortescue show a range of patterns. However, the dominant orientation clusters on all plots suggest a broadly similar
orientation probably representing a dominant palaeoflow direction that differs little from that observed today. As for the stereograph plots drawn up for Yellowford, badly cryoturbated units stand out clearly on the with points clustering towards the middle indicating a high dip angle. Heavily cryoturbated units also show a greater range of variability in clast orientations.

Figure 11: Exposed section at Fortescue Farm, 2006. © L Basell.

Figure 12: Terrace 4 landform at Fortescue Farm, 2006. © L Basell.

4. Fieldwork Summary: River Otter

4.1 Background
Following the phase one evaluation, the most pertinent points regarding the Otter terraces may be summarised as follows:

- Palaeolithic archaeological artefacts have been found in direct association with terrace 5.
- There appears to be altitudinal separation between the terraces.
- There are very few exposures of any of the terraces, and particularly the higher-level terraces.
- No absolute dates have ever been achieved on the terraces associated with the Otter.
- There are nine terraces differentiated by BGS mapping, and a higher terrace noted overlying the Budleigh Salterton Pebble Beds at Blackhill Quarry which has not been mapped by BGS but is recorded in the Geodiversity Audit (Nicholas, 2004). This was examined during phase one and is being actively removed in order to access the Budleigh Salterton Pebble Beds.
- No work has been done on the sedimentology of the terraces, although some attention has been paid to the hanging dry valleys in the catchment (Gregory, 1971).

During Phase 2 fieldwork has been completed at two locations in the Otter Valley, and nearly all mapped terrace fragments in the southern half of the catchment have been examined in trying to identify sites for fieldwork.

4.2 Budleigh Salterton Cricket Field: Terrace 2
Following discussions with BGS it transpired that only three exposures of terrace deposits (other than those visible in cliff sections south of Ladram Bay) existed when mapping of the Sidmouth
sheet was conducted. One of these exposures is at Budleigh Salterton Cricket Field where there is an exposure of terrace 2 about 2.5 m in thickness (Figure 13). This is easily accessible, and logging and sampling for OSL dating has been completed at the site. Two sand lenses were sampled; one within the gravels and one at the base of the gravels at the junction with the Otter Sandstone. These samples have been processed and generated dates of $75 \pm 9$ and $99 \pm 10000$. These are minimum estimates. No clear cryoturbation features were observed though there is some root disturbance from the trees growing above the section. In general the gravel exhibited crude sub-horizontal bedding; there is considerable variability in clast size and imbrication of clasts is clearly visible. No channel features were clear, but this is unsurprising as the exposure is small. The sand lenses also exhibited clear horizontal bedded. The lithology is overwhelmingly dominated by clasts from the Budleigh Salterton Pebble Beds with occasional flint and chert clasts, as for Terrace 7 at Monkey Lane (see below). The date on this terrace is likely to be quite recent.

Figure 13: Terrace 2 Exposure at Budleigh Salterton, 2006. © L Basell.

4.3 Monkey Lane: Terrace 7
Permission was gained from Clinton Estates and the farmer to excavate a trench in Terrace 7 south of Newton Poppleford. A local mechanical excavator and operator were found and a 20 m trench was excavated (Figure 17). Whilst we were working at the site, Dr R. Gallois, (who mapped the Sidmouth area for BGS before he retired) visited. Gravels were exposed overlying weathered Otter Sandstone, along with a raft of clay derived from the Mercia Mudstone occurring at the junction between the two. The form and size of this mudstone indicates that it was transported as a frozen block. The gravels were clearly truncated, and did not exhibit cryoturbation features as seen at the Exe valley sites, although a clear tree throw feature, and palaeochannels were observed. The maximum gravel thickness across the trench was ~1 m 40 cm, but is likely to be thicker in other areas of Terrace 7. The gravel at Monkey Lane is truncated, and would have been a thicker unit in the past. The site is high and exposed, and historically this field has undergone significant episodes of erosion of, which has caused a change in the land management patterns ("Home Farm" Staff, pers. comm. to LSB). Sections were logged at regular (~2 m) intervals, digitally photographed. Clast analysis was conducted on the main units. The site was backfilled and the grass re-sown.

Clast analysis shows no variation in lithologies between the main units (see A3). The clasts are completely dominated by locally derived chert and quartzite with very occasional pieces of flint and sandstone. The stereographic plots show some variability, probably related to different channel flow directions. Three separate sand lenses were sampled for OSL dating. The first of these has been processed and has yielded a date of $116 \pm 17000$, but showed some slightly anomalous behaviour (PT, pers. comm. to LSB). PT believes this to be a minimum estimate. As the date stands however, it places the site within early Oxygen Isotope Stage 4.

Following excavation, a survey was conducted over the terrace fragment (Figures 14 & 15) in this field using differential GPS. The data has been post processed (which means it’s accuracy is
resolved to 10mm vertically and 20 mm horizontally using RINEX data and Leica GeoOffice software), and preliminary 3D modelling of this data is shown in Figure 16. This will be further refined, so that the surface is properly smoothed (“splined”), but even in this slightly crude state it is possible to see a second break of slope within the terrace mapped as a single unit. This shows a greater complexity to the formation of the terrace than can be seen from the mapping, and indicates that two terraces are represented here. Two GPR transects were also run across the terrace. (Figure 19). These show clearly pick up the base of gravels and show some variation within them. Of particular interest were anomalies to the east of the site, which may show an additional terrace feature supporting the GPS model. The fieldwork has shown the gravel to be of significant antiquity. The GPS and GPR surveys support each other in showing that a gravel body mapped as a single unit suggests that two units are probably present. The block of mercia mudstone (just visible in Figure 18) bears witness to conditions very different from those seen in the valley today, although on the whole the palaeoriver Otter was clearly deriving its bedload from local sources as it is today. In addition, structure within the terrace has been preserved showing palaeochannels, and the clast analyses can be used as indicators of palaeoflow directions.

Figures 14 & 15: Image of terrace 7 at Monkey Lane and LSB conducting GPS survey over this. © L Basell
Figure 16: Terrace 7 modelled on GPS data in ArcGIS and ArcScene by LSB. Annotated to show clear breaks of slope which are not especially clear on the ground, and particularly when vegetation is high.

Figure 17: 20 m trench excavated into T7 at Moneky Lane © L Basell
4.4 Ladram Bay Staircase Sequence

Permission was gained from Clinton estates and several tenant farmers to look at the terraces in this area to the west of the river Otter. Some of these terraces lie very high above the current floodplain and must be of considerable antiquity. Much time was devoted to trying to identify suitable locations in this area for excavation, as it is of high geomorphological potential and some extensive areas of river terrace deposits are preserved here. If there were any doubts as to whether “staircase” terrace sequences exist in the south-west, this area conclusively shows such doubts to be unfounded. Terraces 3, 4, 5, and 7 to the north of Brandy Head are clearly stepped topographically (See Figure 20 and Figure 21). Unfortunately, the land has proven either inaccessible or, more commonly, under crop/bio-secure pig units. Numerous photographs have been taken here however, and the gravel exposures in the cliff section to the north of Brandy Head are of note. Where the terrace deposits mapped as a single terrace unit 4 are exposed in the cliff section, sands and silts sandwiched between gravels are clearly visible (Figure 22). The Royal Marines, Lympstone Barracks, were contacted to see whether it would be possible for them to assist in the sampling of these exposed deposits by abseiling. They responded positively, as it fitted in well with their outreach prerogatives and training programmes and a date was arranged. Unfortunately their administration department decided at the last minute that the undertaking was of no outreach benefit.
to them, and that (even after considerable negotiation) it would be necessary for us to pay them a large amount of money, at which point we withdrew and the fieldwork was cancelled.

Figure 20: Terrace deposits to the south of Ladram Bay. Background map is OS data from Digimap licensed to Exeter University. Figure created in ArcGIS by L Basell.

Figure 21: View (to the south-east) of terrace staircase sequence on the coast to the south of Ladram Bay annotated to show terraces. © L Basell.
5. Fieldwork Summary: River Axe

5.1 Background
Following the phase one evaluation, the most pertinent points regarding the Axe terraces may be summarised as follows:

- Palaeolithic archaeological artefacts have been found in abundance at Broom.
- Single findspots of Palaeolithic material are relatively common at a number of other locations in the catchment, but artefacts are found in nowhere near the same quantities as at Broom.
- The terrace sequence is anomalous when considered in relation to the terrace sequences to the east and to the west. The area has been mapped recently, yet only undifferentiated terraces and terrace 1 are found in association with the River Axe. However, some of these terraces are extremely deep, up to ~15 m at Chard Junction for example.
- The gravels of the Axe valley have been more extensively quarried than any of the other terrace deposits under study in the Palaeolithic Rivers of South-West Britain project and continue to be actively quarried at Chard Junction.
- A series of dates have been achieved on the terraces associated with the Axe at Broom. These dates ranged between c. 250000 – 300000 BP (prior to Bayesian modelling), and were obtained by Rob Hosfield and Phil Toms for the terrace deposits at Broom by OSL (Toms et al. 2005).
- Limited work has been conducted on the sedimentology of the terraces away from Broom.

5.2 Kilmington
Work was conducted at Kilmington, which was identified as a major area of interest in Phase I. Numerous landowners were contacted, and permissions gained for geomorphological mapping and access to Kilmington Pit. All areas of past working were examined, although large areas of previously open worked ground have now been backfilled. Elsewhere, sections mapped/described as being visible are so overgrown that it is not possible to see the deposits. Section drawing and logging has been completed at Kilmington Quarry (grid reference 327530 097885) where there are large exposed sections through the terrace deposits. The lower half of these sections are generally slumped and vegetated (Figure 24), but the upper halves are well-exposed, “clean” faces. The quarry is now disused and quite overgrown, but whilst it was a working pit, two Acheulean bifaces and several flakes attributed to the “Palaeolithic” were recovered. Much of the area originally
worked has been backfilled and is used as farmland. A fairly large area remains unfilled though, and access was granted for us to examine the extant faces.

Only the southern, western and eastern faces are made up of in situ gravels. Much of the northern face is backfill. The non-backfilled faces have slumped considerably, leaving a total section exposure of ~9 m. This must originally have been closer to ~14 m. A section 21 m long section was cleaned and drawn in detail (Figure 23), and digitised. Clast analysis was completed on major units seen in the 21 m section. A further five stratigraphic logs were taken along an additional 122.5 m of the southern and part of the western section including the OSL sample location points and digitised. A traverse was conducted using a basic dumpy level to ascertain the height OD, and sediment samples have been taken for pollen analysis. New GPS equipment was used to survey the quarry edges as far as was safely possible, and levels were taken across the site. The tree cover made some of the readings problematic, but the GPS survey was successful and the results have been post-processed and entered into the GIS model of the Axe Valley.

There are clear cryoturbation features in the uppermost units (heaves and clusters), while the lower units tend to exhibit some horizontal bedding and imbrication. Manganese and iron staining occurs in patches throughout. Within nearly all the main gravel units, are discontinuous sand, silt and clay lenses of varying sizes. Some of these have been disrupted by cryoturbation, and some show bedding and cross bedding. The deposits show channel and bar features and the variation in the composition of the sedimentological units are clearly indicative of different flow rates and fluvial processes. All units exhibited the same basic lithology dominated by chert. The stereographic plots of dip and orientation were particularly successful. Aligning the stereographs with the section drawings at the appropriate sedimentological unit different palaeoflow directions can be clearly distinguished.

Two of the four extant sections contained sand lenses suitable for OSL sampling (Figure 23). Four samples were taken and processed by PT. These have yielded dates of 309000 ± 26000, 273000 ± 26000, 179000 ± 18000 and 154000 ± 19000 BP. Due to the antiquity of the samples, they took up a considerable amount of machine time. The dates fall into two groups and satisfyingly are stratigraphically contiguous, with one exception. They date two major units. The oldest dates are at the bottom and the younger ones at the top. On receiving the dates, the location of the exceptional sample was re-examined and the sample location was found to be within a large block of sediment slumped from the upper unit. This means the lower part of the gravel exposure is dated to OIS 8 and the upper part of the exposure dated to OIS 6.

Unfortunately we do not know which unit the artefacts came from. If it was the lower unit, then this makes Kilmington the oldest open-air Palaeolithic site in the south-west region. The dates of ~309000 and ~273000 thousand fall into OIS 8 so it would seem most likely that the artefacts are actually older than the dates on the gravels and represent a human presence in OIS 9 or more likely OIS 11. If they come from the higher unit, with the dates of ~179000 and ~154000 then they could reflect a human presence in OIS 5. It seems more likely however that they have been reworked from the older deposits. These are reliable dates, which are older than those from Broom. This makes Kilmington the oldest dated open Palaeolithic site in the South West region and has important implications for models of the occupation of Britain.

Geomorphological mapping of the paired terraces in this region has been completed by Jenny Bennett (JB) (Figure 26 and A.6). Despite the crop cover over many fields some significant geomorphological features were revealed through this survey. Although the area has been mapped by BGS as Undifferentiated terraces, there are clearly altitudinal differences between discontinuous terrace patches. On specific swathes of terraces several large breaks of slope have been mapped by JB. This shows there is much greater complexity to these deep gravel deposits than can be gained

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simply from examination of the BGS mapping, as for their purposes it was only necessary to note the limits of the terrace form, and not variability within it such as these additional breaks of slope. It should also be noted that valleys, which must post-date the formation of the terraces, repeatedly cut the river terraces. LSB has also discussed previous work undertaken in the Axe Valley with Dr R. Shakesby, University of Swansea.

Figure 23: Part of 21 metre section at Kilmington, looking west (left), January 2006. General shot of quarry, looking southeast, with the southern section clearly visible (right), January 2006. © L Basell.

Figure 24: Slumping and vegetation on the old quarry faces at Kilmington: southern section, viewing to the east, January 2006. © L Basell.

Figure 25: Cross-bedded sand lens, Kilmington, being sampled for OSL dating, January 2006. © L Basell.
5.3 Chard Junction

Permission was obtained to work in this pit, from the quarry managers (there has been a personnel change during Phase 2) and with full agreement from Bardon Aggregates. They have been extremely helpful, and very interested in the work we have been conducting. This is an active pit which continues to extract river terrace deposits in the Hodge Ditch Farm area (grid reference 335135 104735 Figure 29). The late John Wymer found a biface at the pit some years ago whilst on a QRA/INQUA trip (Wymer, 1977; C. Norman pers. comm. to LSB, Figure 27), and several other bifaces are recorded in the HERs as having come from Chard Junction Pit. The site is ideal as it has only recently been opened so it has been possible to see all the major units before they have been removed completely and the site has been visited repeatedly during Phase 2. OSL samples were taken from three separate sections and at different depths and locations in the active pit. A further sample was taken from the base of an extant section in an area now being used as a silt pond. Two long sections were logged, sketched, and photographed. These covered the locations of OSL samples CHAR01 and CHAR03. The sections (one of 110 m and one of 21 m) were both logged at 5 m intervals. The locations of the other two OSL samples (CHAR02 and CHAR04) were not logged due to operational constraints, but they were photographed and their heights OD surveyed in. Examination of the records shows that there are effectively two major units currently visible at the Hodge Ditch Location. The uppermost unit most closely resembles a debris flow deposit, whilst the lower is clearly fluvial. Cryoturbation features are visible to varying degrees throughout these units. These include heaves, clast clusters and ice
cracks (Figure 28). There is considerable lateral and vertical variability in the composition of the major units at the pit. Channels features run through the deposits with sand/silt fills, as well as gravel showing imbrication. Many of the sand/silt deposits exhibited superb bedding structures and several sarsen stones have also been recovered from Hodge Ditch. Samples of organics were also taken (see Environmental Assessment Document) but clast analysis was not undertaken due to the complexity of the stratigraphy and size of the working. Lithologies were noted and were dominated by chert and flint. Judging by the orientation of the channel features and imbrication, the dominant palaeoflow direction was similar to that observed in the Axe Valley today, although the multiple channels indicate a braided stream environment so some variability in the flow directions is naturally apparent.

The gravels at Chard Junction extend to a maximum thickness of 15 m, which is an unusual amount for Pleistocene terraces in the British Isles. A series of dates is now available for these and as predicted are of similar antiquity to the Kilmington and Broom dates. The first dates are on the junction between the upper debris flow deposits and then lower fluvial deposits, and are statistically within the same time range. They are 98000±8000 and 94000±9000 BP dating the top of the fluvial unit to OIS 4. At the very base of currently exposed deposits, a second date of 174000±18000 was achieved. The antiquity of these samples means they took up considerable amounts of machine time. A further date of 274000±74000 was obtained from the sample taken from the base of the silt pond section in the former workings. The examination of large lateral extents of gravel is particularly informative about the conditions under which the gravel accumulated and the processes which then affected it post-depositionally. The excellent series of stratigraphically contiguous dates fall in line with those from Kilmington and Broom. It is now possible to resolve the relationship between these sites. As the deepest deposits exposed at Chard so far are yielding dates within OIS 6, it seems quite feasible that the remaining ~8 m of gravel known to exist at Chard Junction will be even older than the deposits observed already. Given the time ranges covered it is possible and indeed probable that interglacial deposits may be preserved and there is a possibility of further archaeological finds from this site.
5.4 Broom

As a considerable amount of work has previously been conducted at Broom by other projects (e.g. Hosfield & Chambers, 2004: Ch. 3-4), no work was planned here during Phase 2 except to “test” the GPR. Due to problems with the equipment (see above under Yellowford) and operator availability, this was conducted towards the end of Phase 2 rather than at the beginning. One transect was successfully run across the Railway Pit (T1). (Figure 30). Examination of the GPR transects shows some interesting anomalies, but could not distinguish the base of gravels. The anomalies suggest that the GPR is picking up sedimentological crude variation within the gravels but problems were encountered due to the high water and made ground. Given the depth of gravels now known from the Chard Junction borehole data (Bardon Aggregates pers. comm. to LSB), and the gravel thickness visible in the extant faces at Kilmington and Broom it is unsurprising that the base of gravels could not be detected. Workings at Broom Railway Pit were quite extensive, but only reached the base of the Middle Beds, so a considerable body of gravel (some of which lies below the water table) is likely to remain in this area. (See also Figure 31)
6. Fieldwork Summary: Palaeoriver Washford

6.1 Doniford
This site was mentioned as being of importance in the Phase 1 project design (Hosfield & Brown, 2005), as it is one of the most westerly sites in the UK where Palaeolithic finds have been retrieved from a stratified context. The site has yielded bifaces and mammoth remains (Figure 33) and is an SSSI, so permission was gained to work at the section from the relevant authorities. The site lies in Somerset (grid reference is 308701 143172), extending the coverage of the Phase 2 fieldwork beyond Devon and Dorset. These finds came from river terrace deposits associated with the palaeoriver Washford. The site has proved very interesting and useful for outreach purposes as well as for research. After visiting Watchet Museum, meeting and talking with Mr R. Wedlake (son of A.L. Wedlake, who discovered the artefacts), it became clear that there has been considerable erosion at the site in recent years. The last work conducted on the sedimentology was in the 1960s including some clast analysis, and the cliff is thought to have eroded at a rate of approximately 1m/year since then. Photographs at the museum showing gun mounts some distance inland from the cliff edge support this. These now lie on the beach (Figure 32). The major units of a 150 metre section of the cliff were drawn to scale and the OSL sample locations were recorded. Photographic logs were also taken. The height of the section above sea level was ascertained by a traverse using a dumpy level. Organics were found in some of the gravel units and were sampled (see Environmental Assessment Document).
The deposits at this site are complex. Some units are very disturbed by cryoturbation and contain clasts that have been split in situ by freeze/thaw processes (congelification). Other units are bedded and not affected by cryoturbation. OSL samples were taken from five locations along the section. Five good OSL samples were taken and results received from PT of 51000 ± 4000 BP, 49000 ± 5000 BP, 45000 ± 5000 Kyr BP on the basal gravels, and 25000 ± 3000 BP higher up the sequence. The dates support the idea that the river deposits were reworked several times, and obviously date the latest reworking rather than the depositional event associated with the initial inclusion of the artefacts. It is highly likely that the Doniford artefacts were originally lying on a terrace level in the Washford Valley that may have corresponded to the present day Terrace 2 of the River Tone, where similar artefacts have been found. Over several climatic cycles the terrace has been eroded and eventually deposited by the periglacial palaeo-Washford.

Figure 32: Doniford cliff section with Phil Toms undertaking OSL sampling. © L Basell.

Figure 33: Sample of Doniford Palaeolithic artefacts and Pleistocene faunal material on display in Watchet museum. © L Basell.

7. Note on Organic Samples Taken

Many of the sites mentioned above were sampled for organics. All samples have been processed and pollen was poorly preserved in all cases. Where pollen grains could be identified, cold species were represented, but in no case was the quantity statistically significant, or enough to warrant further comment. See Environmental Assessment Document.

8. Additional Fieldwork Activity

In addition to the scheduled fieldwork completed during Phase 2 of this project, a number of additional tasks were also undertaken.

8.1 Other Sites Examined, but found to be unsuitable for Fieldwork
Further suitable sites which were examined to ascertain whether they would be appropriate for fieldwork are listed below. Naturally permissions also had to be obtained to conduct this work, and it should be noted that a large number of additional sites were examined which were not suitable.

- **Terrace 5 near Broadclyst, (River Exe).** This was a suitable site, and permission was gained from the landowner to excavate a trench in his field. This is associated with the Clyst (tributary of the Exe). Shortly after obtaining this permission, and completing the relevant correspondence to the landowner, LSB went to arrange specific dates for excavation, but the farmer had ploughed and sown the field, making any further work impossible.

- **Terrace 5 at Hayne Barton (River Exe) and near Newton St Cyres (River Exe).** Much time was devoted to identifying an area of terrace 5 in association with the Exe that would be suitable for excavation. Despite willing landowners, work on these deposits has been prevented by crops, tumuli and other archaeological features. The Hayne Barton site was examined by AGB, LSB, Dr R. Scrivener and Lord Iddesleigh. Permission was gained to excavate a trench in this large swathe of terrace 5, but as it was under crop, it was not been possible to conduct work here.

- **Terrace 4 Hayes Farm Quarry (River Exe, grid reference 299300 094400) was visited.** The importance of this quarry, where terrace 4 sand and gravel deposits have been recently removed, was discussed in the Phase 1 report (Hosfield et al., 2005: 54). The altitudinal separation of terrace 4 from the lower terraces and its impressive form suggest it is associated with a major event (also discussed in the Phase 1 report (Hosfield et al., 2005: 27)). The site is currently dormant, but the possibility of future extraction there remains, provided the correct permissions are obtained. It has largely been graded. The site was visited and the extant sections were examined to see whether there were any suitable locations for dating. It was clear from the sorted heaps of gravel that the river gravels here have been exploited in the recent past. In one small section, some undisturbed gravels were located, but the exposure was too limited and the lack of suitable deposits for dating mean this site cannot be used for fieldwork.

- **Terrace 2 south of Monkey Lane in the river cliff section by the River Otter.** Permission was gained to sample here, and the section was cleaned and examined. However no deposits suitable for dating were identified.

- **Blackhill Quarry (Rivers Exe and Otter).** The geodiversity audit recorded gravels here high on the interfluve between the Otter and the Exe, though they were not mapped by BGS. These were examined during Phase 1 of the project, and recently re-examined in Phase 2 to see whether there were any deposits that were accessible for sampling. The quarry manager has recently changed, but both quarry managers (CAMAS Aggregates) have been interested, more than accommodating, and indeed very keen for us to work at the site. Although suitable deposits do exist in the river gravels overlying the Budleigh Salterton Pebble Beds, these are at the top of large sections surrounding a lagoon, and could not therefore be used for this project.

- **Honiton Hippo Site (River Otter).** There was some communication with Dr C. Turner about conducting work at this site – possibly by coring. Due to problems regarding the exact location of the original excavations, and Dr Turner’s assertion that the deposits were soliflucted, this was abandoned as a potential fieldwork location. It is worth noting however, that even if the deposits were soliflucted, dating the deposit would not be irrelevant. A minimum age could be ascertained for the faunal material from the site, and dating the solifluction would be useful in modelling more precisely the palaeolandscape evolution of the area.

### 8.2 BGS, Sidmouth & Private Artefact Collections

Following a recent article in PAST (the Newsletter of the Prehistoric Society) LSB visited BGS Keyworth to look at several small collections of artefacts, which were collected by geologists in the south-west region. These were examined along with the collectors’ notebooks, and photographs and notes were taken. In addition, C. Norman invited LSB to examine and discuss some of the Palaeolithic finds from Somerset and to examine the river terraces in the Taunton region following communication with S. Minnett. C. Norman catalogued and collected some of the lithic material.
from Doniford. This was largely Mesolithic material, but it also transpired that he has made some significant collections of Palaeolithic material by fieldwalking in Taunton Vale. LSB went to examine the lithics, which were particularly interesting. Many were quite fresh suggesting they have not moved significant distances or been exposed for long periods since deposition. Both assemblages consisted of bifaces, but also included cores, flakes and occasional retouched pieces. On the basis of this, LSB then returned with TB to visit the sites at Cotlake Hill and Norton Fitzwarren with Mr Norman. This was extremely instructive, and the artefacts from Norton are clearly associated with Terrace 2 of the River Tone. Some further enquiries were made to see whether this might be worthy of further investigation, but this unfortunately proved unfeasible within the Phase 2 timeframe. Prof B. Coles was also visited to examine some artefacts she thought may be bifaces (one was previously found in her garden), but these were not artefacts.

9. GIS

This work was effectively the extension and improvement of the GIS model and database developed during phase one of the project for Devon. A draft version of this, covering the whole of the south-west region was completed for the phase two workshop (July 2006) permitting HER staff and other potential users of the model to comment on it. The outcome was that although HER staff thought the model was interesting, and could see how it had been useful in analysing the data collected as part of the PRoSWeB project, their particular request was for shapefiles, photographs, and “blocks” of information on any new work generated by the project, as well as metadata relating to each of these. Obviously the analysis and interpretation of the new fieldwork data is ongoing until the end of the project, and HER staff requested that they would prefer to wait until the end of the project to ensure all data was received at the same time. Discussions over preferred formats and metadata with the HERs is ongoing.

IFSAR data and orthorectified aerial photographs were also purchased during Phase 2 of the project. These have now been entered into GIS and examined in ArcScene at different resolutions (e.g. Figure 35). The data, like the geomorphological mapping, clearly shows considerable complexity in the terraces mapped as undifferentiated and terrace 1 in the Axe Valley. The landscape form is much more easily interpreted and understood using this data, and the valleys that cut into the terrace deposits can clearly be seen. Using slight vertical exaggeration and shading it has also been possible to pick out even areas of minor quarrying and geomorphological features. A basic example which clearly shows previous extraction areas now used as silt ponds at Chard Junction is shown in Figure 34.
Figure 34: Example of view generated in Arc Scene using shading but no vertical exaggeration to highlight topography and geomorphology in the Axe Valley around Chard Junction by LSB.

Figure 35: Drape of orthorectified aerial imagery view over digital terrain model generated in ArcGIS by LSB.

10. Fieldwork Conclusions
The fieldwork and dating programmes have been successful and extensive, and have the potential to provide after analysis, the first chronological framework for the hominin occupation of south-west England. The fieldwork results clearly indicate that the Phase 3 analysis will increase our understanding of, as well as provide an initial synthesis of Lower and Middle Palaeolithic
archaeology and hominin occupation of the south-west Britain region. In addition the project will enhance the county HERs with new data generated through fieldwork. Analysis of the fieldwork data will allow the refinement of these models and outputs, ultimately providing an interpretation of palaeolandscape evolution in the south west region over the last ~500,000 years.

Edwards (Edwards & Scrivener, 1999: 135) wrote of the terraces associated with the Exe: “There is no good evidence for dating the terraces”. Other than the two unpublished dates on terrace 3 of the Exe and the dates from Broom, no chronometric dates were previously available for any terrace systems in the south west region. The dates reported here provide the basis for a chronological framework for the river terrace sequences of the south-west and their associated archaeological artefacts. These show terrace deposition from as early as OIS 9 and demonstrate reworking of deposits during OIS 3. This suggests that significant revision of previous relative chronologies will be required.

All these dates have implications for the archaeology and hominin occupation of the south west. For example, the dates from Kilmington and Chard Junction suggest a very early hominin presence in the area and support the new dates from Kent’s Cavern (Proctor et al. 2005). The finds from Doniford have finally been properly contextualised and show that episodes of reworking may be very important in the accumulation of archaeological material. The types of processes suggested by the sedimentology at all sites dated to OIS 3, shows that these reworking episodes could technically mix older archaeological material with more recent artefacts. At Doniford there was no evidence for this. Rather, the reworking occurred episodically, forming a series of deposits with stratigraphic integrity, where the oldest deposits occur at the base and the youngest at the top. The number of dates indicating OIS 3 cryoturbation/disturbance/reworking also demonstrates how dynamic palaeolandscape evolution has continued to be right into periods associated with the Upper Palaeolithic and Homo sapiens sapiens. Resolving the differences between supposedly cold stage gravels at Chard and the other Axe sites was stated as a goal right from the beginning of the project, and the excellent dates from Chard and Kilmington have given us a handle on this.

The fieldwork has reinforced the point made during project phase one that there is significant inter-valley variation. A much better understanding of the causes of this variation has been gained showing that one of the principal causal factors is geological/geomorphological processes. Importantly this work demonstrates that while the Rivers Exe and Otter are clear staircase strath terrace systems, the Axe is a fill terrace system. The gravels here are made up of different units as recorded in the sedimentological logging, and both the geomorphological mapping and the modelling show there are altitudinal differences, and features within units mapped as a single terrace. This demonstrates that their evolution is multiphase. I.e. that they are compound terraces. The difference between these fill terraces and the Exe and Otter where staircases are forming must be related to an abundant local supply of clasts from the weathered Cretaceous and Tertiary material from the Blackdowns; but a lack of main channel discharge capable of removing this material and incising. That is until the downcutting that occurred when last glacial sea level was reached. Collectively then the methods of analyses employed during Phase 2 are allowing us to discuss how the terraces formed, thereby contextualising the archaeological material with which they are associated. This formation of the gravels has affected the spatial and temporal patterning of the intra-gravel archaeological record. A key implication of these preliminary findings is therefore that the inter-valley geological variation must be better understood in order to allow any archaeological evaluation of the Palaeolithic record. Clast and sedimentological analyses in the Otter and Exe Valleys in combination with the dates also suggest factors such as lateral erosion of the valley floor, reworking of terraces, to be important. This supplements Bridgland’s model of terrace formation.

Conducting the fieldwork has emphasised how significantly different the landscapes of the south-west region must have been during the Palaeolithic/Pleistocene. Take for example Figure 37 which
is a map of superficial deposits against a basic OS map of the Nether Exe Basin. The main river channels today are shown in blue, and the alluvial deposits in yellow, probably representing deposition from late stage 2 onwards. The red areas represent paired terrace 7, so are quite high lying on the 50 m contour line. If one assumes that all areas below terrace height today were at or below floodplain height at the time of terrace deposition and there has not been significant neotectonic movement in the area, then it is possible to fill in the areas that would have been the previous floodplain (the green area in Figure 38). This shows where was far less topographic relief in the past as represented by the green fill. These would have been wide stretches of braided rivers, which certainly supported different faunas. In combination with the dates, it seems the majority of these changes have occurred over approximately the last 500000 years, which in geological terms rapid. Even though the pollen data from the samples collected were not well preserved, the fieldwork results already indicate that the landscapes in the south west over the last 500 000 years have been altered dramatically. Analysis of the fieldwork data will allow us to assess at what times the area would have been amenable to hominin occupation.