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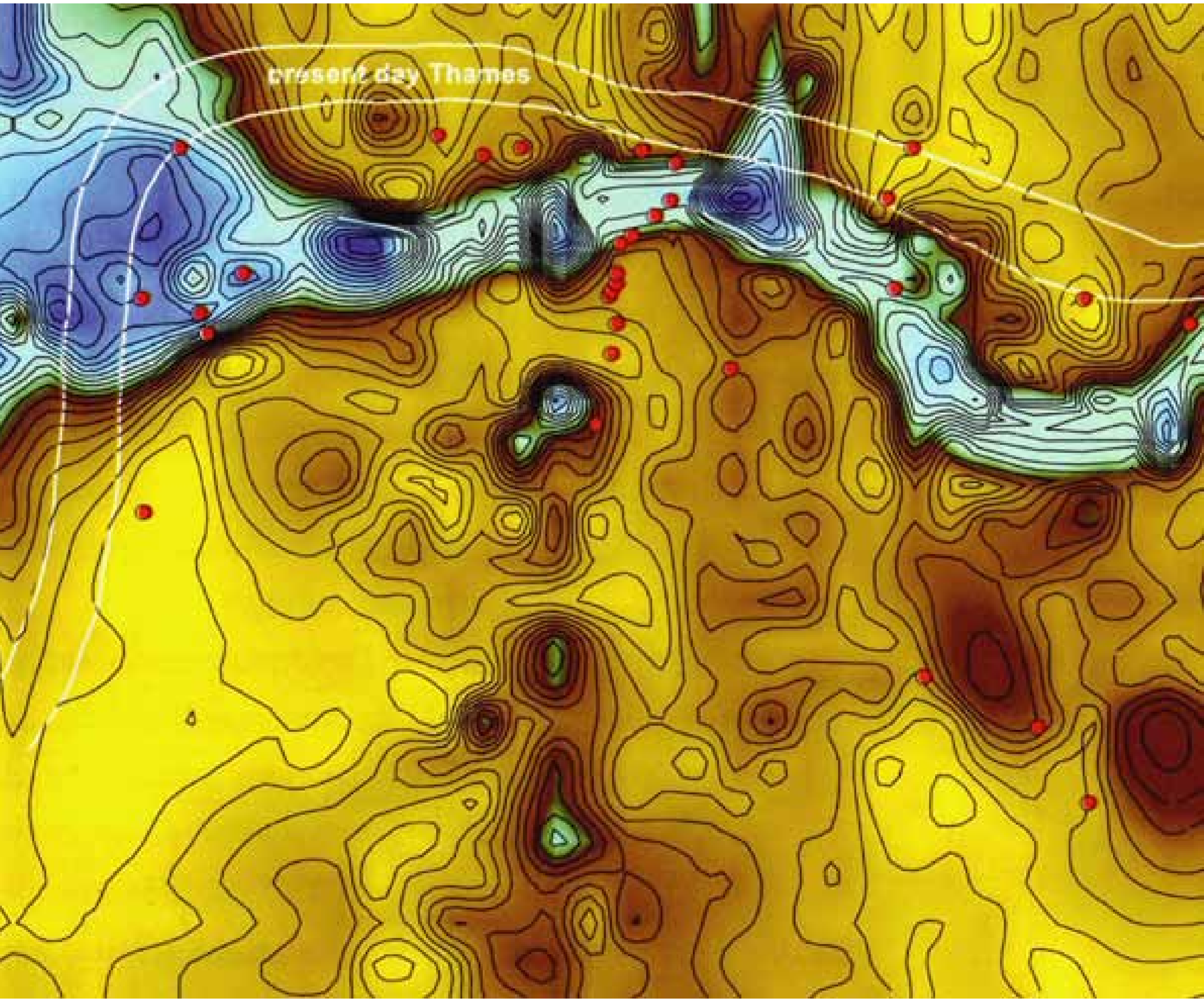
SOUTHERN REGIONAL REVIEW OF GEOARCHAEOLOGY
ALLUVIAL DEPOSITS

ENVIRONMENTAL STUDIES REPORT

Gianna Ayala



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Summary

This review aims to consolidate in a unified discussion the body of major published works that have defined the field of alluvial geoarchaeology in the south of England to date. The geoarchaeological research presented here has arguably played a leading role in refining recent academic interpretations and influencing the direction in which the archaeology of these wetland landscapes has evolved in the last 30 years. The discussion is framed chronologically starting with the Pleistocene and continuing through the Holocene. Within each of the chronological sections, key research questions and the application of different methodologies are introduced. Issues of site formation and preservation, environmental reconstruction, human impact and relationship to landscape change are introduced through a series of case studies from the lower Thames to the coastal estuaries of Cornwall.

Keywords
Geoarchaeology
Geochronology
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Burial Environments
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1. Introduction

Alluvial archaeology has been defined as the interdisciplinary study of the history and dynamics of human settlement in river valleys. It seeks to understand the way that past populations impacted upon the riverine environment, and how communities reacted to long and short-term variations in river regime (Needham and Macklin 1992). Key research themes of alluvial geoarchaeology therefore need to include assessments of the potential resources of river valley landscapes to human communities (Evans 1991) and analysis of the utilisation of particular river zones (Robinson 1978), through to identifying causal mechanisms of changing catchment hydrology. Further to this, alluvial stratigraphy is studied in tandem with archaeological excavation to enhance interpretation of site formation processes. Temporal and spatial variability in river dynamics affects the preservation and visibility of the archaeological record in alluvial environments. It is now established practice that riverine environments are analysed most effectively through a multi-disciplinary approach based upon the geomorphological study of landform development that acts as the precursor to detailed archaeological study (Howard and Macklin 1999).

This regional review is intended to provide an introduction to the study of geoarchaeology associated with alluvial deposits in southern England. The rivers of southern England (Figure 1) are mainly lowland rivers, with low channel gradients, low angle valley side slopes and well-developed floodplains. These rivers are often low-energy systems with cohesive channel banks and tend to carry fine sediment load, due to the low erodibility of their banks.

Lowland river systems also have the benefit of increased preservation of alluvial units. In comparison to the upland glaciated river basins which experienced relatively high rates of channel incision and lateral reworking during the early Holocene, lowland unglaciated river basins have been characterised by episodic aggradation throughout the Holocene. This has led to higher rates of fluvial unit preservation (Lewin and Macklin 2003; Johnstone *et al* 2006). Moreover, the lateral stability and accretionary nature of these low-energy lowland systems has provided relatively good preservation of archaeology. Sites are often preserved within or under thick sequences of fine sediment or peat that benefit from locally high water tables (Howard and Macklin 1999). In these situations, environmental remains are preserved which allow not only the environmental reconstruction but also offer the possibility of high resolution dating of archaeological sites.

The discussion that follows will be framed chronologically starting with the Pleistocene and continuing through the Holocene. Within each of the chronological sections, key research questions will be introduced. For example, the Pleistocene deposits of the major rivers of southern England have provided us with one of the most intensively studied Lower and Middle Palaeolithic landscapes in England. For this particular period two key issues have been firstly the application and evaluation of different dating techniques to refine geochronologies, and secondly how we can interpret archaeological finds in secondary deposits. In contrast, for Holocene sequences of southern England the predominant research theme has been the assessment of human impact on alluvial landscapes as seen in evidence ranging from increased sedimentation to the contamination of sediments from industrial activity.

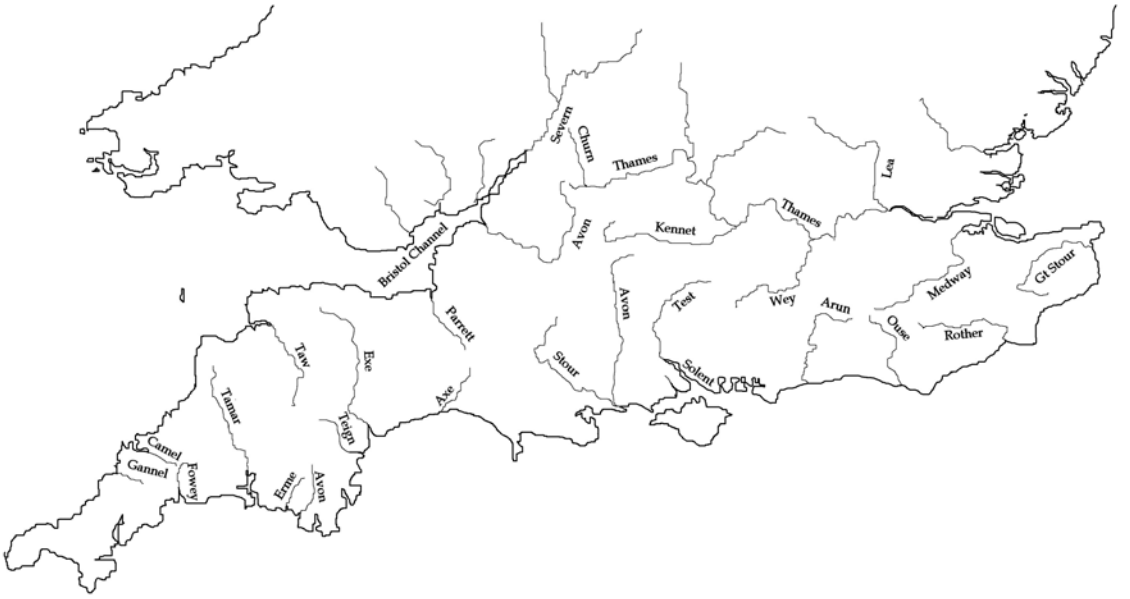

Figure 1: Main rivers of the southern region of England

2. The Pleistocene

Much of the Quaternary sequence of the south of England has been based on the study of river terraces. Deep chronologies of river terraces have provided a framework for palaeoenvironmental evidence for most of the period of human occupation of Britain. The poor preservation of the early relict terraces and more importantly the lack of datable material within their deposits have led to the creation of a number of contrasting models of depositional activity. These models have been developed to explain fluvial responses to the dramatic climatic shifts during both glacial and interglacial transitions of the Middle and Later Pleistocene (Bridgland and Maddy 1995; Bridgland 2000; Bridgland *et al* 2004, Gibbard and Lewin 2002, Lewin and Macklin 2003).

Specifically, Bridgland has suggested that valley incision has often taken place at the warming phase of the climatic cycle when eustatic sea-level rise would have forced aggradation at the seaward end of rivers (Bridgland and Maddy 1995; Bridgland 2000). One of the effects on these aggrading river systems would have been their repeated submergence by marine transgression during interglacials (Bridgland *et al* 2004). The correlation of these Pleistocene terrace deposits and shallow marine sequences has been identified on the Sussex Coastal Plain (Bates 2001).

2.1 The South East

The Lower Thames sequence has been thoroughly studied (see the seminal papers of Gibbard 1985, 1994, 1995; Bridgland 1994, 1995) not only because it is one of the largest river systems in the country but also because of its fortuitous exposure in many of the quarries and recent development programmes in and around London. The Thames was diverted into its current valley during the Anglian where it proceeded to lay down extensive gravel deposits prior to reaching the sea. Archaeological interest in the Thames alluvial deposits and the raised beaches of the south-east coast is also due to the presence of significant Lower and Middle Palaeolithic artefacts and hominin remains within these deposits.

The modern floodplain of the Lower Thames, downstream of central London, is bounded either by older Pleistocene sands or gravels at the higher levels or by bedrock. The depositional chronology of the Thames gravel terraces has yet to be universally accepted and the two major sequences have been proposed by Gibbard (1985) and Bridgland (1994) (for complete discussion see Brown 1997: 162-167).

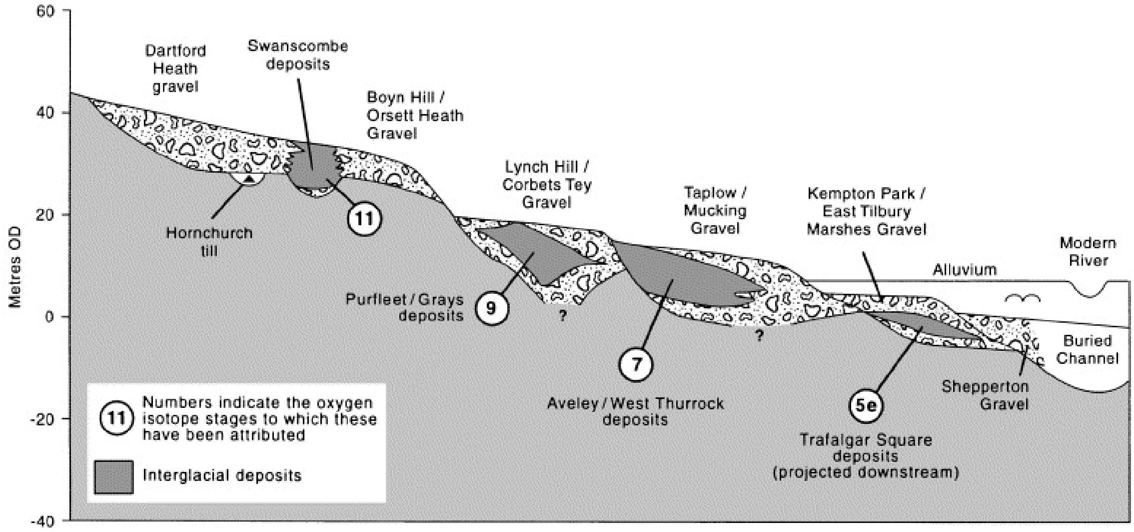

Figure 2: Idealised section through the Thames valley showing the stratigraphical position of the gravel terraces. (Bridgland 2000)

Within the Lower Thames valley there have been significant archaeological finds which have been used to help establish the chronology of the Pleistocene sequence (Bridgland 1995)(Figure 2). Many of the deposits have lithic assemblages in undisturbed or relatively undisturbed contexts, sometimes associated with faunal or other organic remains that have provided ample palaeoenvironmental data to aid in the reconstruction of "the changing geography of Palaeolithic landscapes" (Brown 1997).

Deposits in the Lower Thames valley have been exposed due to extensive gravel and chalk quarrying which has taken place since the late 19th century. Many of these exposures have provided sequences of deposits which contain artefacts attesting to different phases of human occupation spanning the Palaeolithic, such as Swanscombe (Conway *et al* 1996), Purfleet (Schreve *et al* 2002), Crayford (Roe 1981) and the

Ebbsfleet Valley (Wenban-Smith 1995). In general, older remains tend to be associated with the deposits of the Boyn Hill/Orsett Heath Formation (Wenban-Smith *et al* 2006). The deposits consist of a sequence of predominantly fluviatile silt, sand and gravel units laid down by the early Thames in the Marine Isotope Stage (MIS) 11 (Bridgland 1994). Younger remains have been found in deposits in the Ebbsfleet Valley, which cuts down through the Boyn Hill/Orsett Heath deposits (Wenban-Smith *et al* 2006). The Ebbsfleet deposits (Figure 2) have exposed archaeological material in association with elephant remains and it appears to have been a butchery site (Wenban-Smith *et al* 2006). Recent work has been undertaken in the area of Swanscombe mapping these deposits and the palaeolithic finds within them, but has yet to be published (see Wenban-Smith *et al* 2006 for full discussion).

The site at the Purfleet Chalk Pits Site of Special Scientific Interest (SSSI)(Figure 3) has contributed to our understanding of the Lower Thames sequence by identifying a previously undefined late Middle Pleistocene interglacial along with another three interglacial deposits (Schreve *et al* 2002). The sequence spans from MIS 10 to 8 and investigations have shown that the deposits were of Thames origin. Archaeologically the site preserves an important stratigraphical sequence of Lower and Middle Palaeolithic industries, Clactonian, Acheulean and Levallois assemblages which is rare for a site of this type. In fact the few Levallois flakes that were recovered from the Botany Gravels (attributed to MIS 8) make this one of the earliest Levallois sites in Britain (Schreve *et al* 2002).

At this site the most abundant finds come from the lower Bluelands Gravel and have been classified as Acheulean. Their condition has implied that they had not travelled far prior to redeposition and the authors have suggested that they originated from activity areas only metres away on the banks of the river (Schreve *et al* 2002,1454). The presence of artefacts in the lower part of the sequence has suggested a Clactonian occupation although artefacts with clear characteristics were not identified (Schreve *et al* 2002,1455). The presence of artefacts throughout the sequence indicates human presence in the region during both cold and temperate episodes of the late Middle Pleistocene.

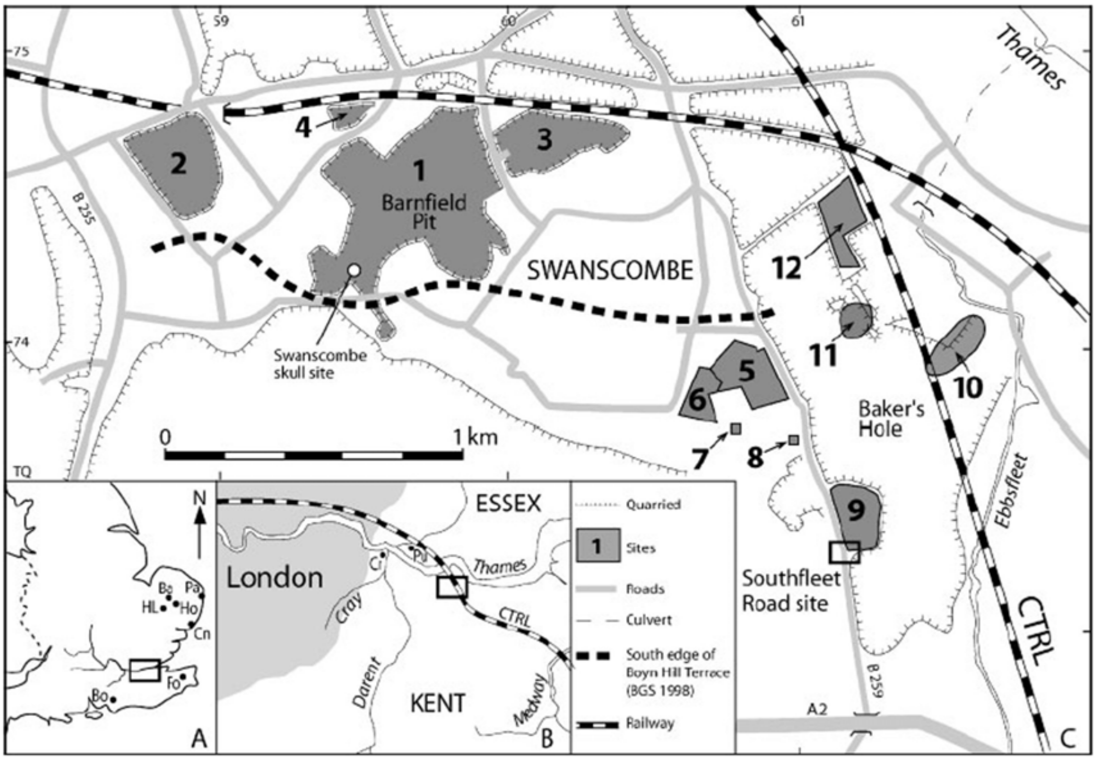

Figure 3: Southfleet Road location showing Channel Tunnel Rail Link and key sites mentioned in text: (A) within UK: Bo, Boxgrove; Ba, Barnham; Cn, Clacton; Pa, Pakefield; Ho, Hoxne; HL, High Lodge; Fo, Fordwich; (B) within Lower Thames: Cr, Crayford; Pu, Purfleet; (C) within Swanscombe area: 1, Barnfield Pit; 2, Globe Pit, Greenhithe; 3, New Craylands Lane Pit; 4, Dierden's Pit; 5, Swan Valley Community School; 6, Sweyne County Primary School; 7, Eastern Quarry, test pit 7; 8, Eastern Quarry, test pit 8; 9, New Barn Farm; 10, Southfleet Pit Levallois site; 11, Burchell's main sites; 12, Northfleet Allotments. (Wenban-Smith et al 2006)

2.2 The Solent and South West

Historically, the rivers of the South West of Britain have not been the focus of the same amount of scrutiny as the Thames and rivers in the South East. This is being rectified by projects that have proposed conceptual models of fluvial systems (Brown *et al* 2010) and systematic dating of available terrace deposits (Toms *et al* 2005, Hosfield and Chambers 2004, Brown *et al* 2010, Briant *et al* 2006). There are several documents currently available that have excellent summaries of the palaoenvironmental and archaeological evidence for the south-west region including that derived from alluvial deposits (Webster 2008, Brown *et al* 2008, Brunning 2008).

The Solent, another of the major river valleys of southern Britain, has a well-studied Pleistocene sequence that occurs within the Portsmouth–Southampton corridor (Allen and Gibbard 1993, Velegrakis *et al* 1999; Bridgland 2002, Bridgland *et al* 2004). These deposits typically consist of coarse flint gravels laid down under cold-climate conditions by a high discharge river that was confluent with the Channel River (e.g. Velegrakis *et al*

1999; Bridgland 2002). A series of terraces have been identified both to the west as well as on the eastern edge of the Solent (Allen and Gibbard 1993, table 3; Edwards and Freshney 1987). A significant quantity of Palaeolithic artefacts has been recovered from these terraces (e.g. Wymer 1999, Hosfield 2001), which at times have been used to attempt dating the terraces (Bridgland 1996; 2001). Dating is still a problem for this sequence, and there are only tentative correlations with the MIS record (Bridgland 2001) since there is limited biostratigraphic evidence from the deposits (Bridgland and Schreve 2001).

As part of the 'Palaeolithic Archaeology of the Sussex/Hampshire Coastal Corridor' Aggregate Levy funded project, a programme of optically stimulated luminescence (OSL) dating was undertaken on terrace deposits from the western Solent (between Bournemouth and Southampton) to refine the geochronology of the Solent terrace sequence (Briant *et al* 2006). This terrace system has proven difficult to date in the past due to the lack of marker horizons and organic material that would provide biostratigraphical control and the possibility for absolute dating. The project was successful in securely dating terraces from MIS 7-8 to MIS 3-4. The authors feel that their results may support other chronological models in the area (namely Westaway *et al* in press, cited in Briant *et al* 2006) and recent studies in other fluvial contexts in Europe that would suggest that there were multiple phases of aggradation within MIS7. This could demonstrate that the extreme climatic fluctuations between the sub-stages may have brought rivers to thresholds which are normally associated with glacial/interglacial transitions within a single temperate stage (Briant *et al* 2006:521).

The fluvial sequences of the nearby river valleys in Sussex that have undergone study have been found to be less extensive than those of the Solent system (Bates 2001) (Figure 3). Studies on the Arun Valley (Bridgland *et al* 2004). have successfully mapped six terraces and attempted to establish a chronological framework in which their formation took place. In areas where the river enters the coastal plain the interrelationships between marine and terrestrial records can best be observed between the raised beach and terrace deposits. Although the sediments are almost devoid of dating evidence, their interrelationships with the well-dated beach deposits could suggest that some of these terrace deposits could be ascribed to the late Middle Pleistocene (Bates *et al* 2000, Table 3, Bridgland *et al* 2004).

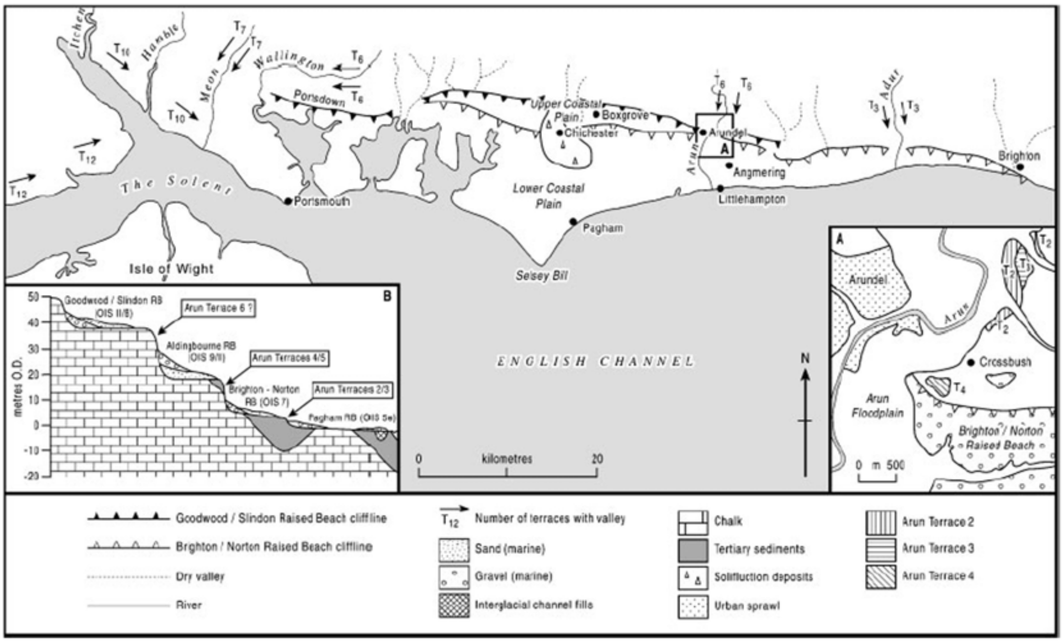

Figure 4: Interrelations between terraces and raised beaches near the Sussex coast, southern England. Inset A shows detail of the terraces in the Lower Arun and their relationship to the Brighton–Norton Raised Beach. Inset B is an idealised section through the staircase of south-coast raised beaches, showing the stratigraphical position of the Arun terraces (Bridgland et al 2004)

Recent work on gravel deposits in Wiltshire has identified an alluvial fan developed at the confluence of the Churn – Thames (Lewis *et al* 2006). The sequence described at Latton, Wiltshire has deposits that appear to be derived from the River Churn instead of the Thames itself that span from MIS 7 to MIS 2. In the earliest deposits (Association A) palaeontological evidence indicated that they were deposited during an interglacial period. Geochronological isotopic evidence from the bones recovered within this Association along with archaeological evidence in the form of rolled palaeolithic handaxes suggests a MIS 7 age (Lewis *et al* 2006, 203; Ashton and Lewis 2002).

Slightly further to the south-west, a number of river valleys have produced new information on later Pleistocene gravel terraces (Table 1). The Palaeolithic Rivers of South-West Britain project has investigated the gravel terraces of the Axe, Otter and Exe valleys and has identified and dated stepped terrace sequences (for the Exe and Otter Valleys) and fill terrace sequences (to the Axe Valley) and put forward new conceptual models for their development (Brown *et al* 2010, Toms *et al* 2005, Brown *et al* 2008, Brown *et al* 2009). A programme of OSL dating has been undertaken at field sites along the River Axe (Broom, Kilmington Pit and Chard Junction Pit) that had relic terraces with gravel deposits within which were Early Palaeolithic artefacts. At Broom a series of dates was produced for the river terrace deposits (gravels, sands and organic clays), spanning late MIS 9 and MIS 8 (Toms *et al* 2005, Hosfield and Chambers 2004). Work on the terrace gravel remnants at Kilmington Pit on the River Axe has also produced 4 OSL dates on a terrace which has produced palaeolithic artefacts that place two major units between MIS 8 and MIS 6. Further work undertaken on the fluvial deposits on the terraces of the River Axe, at Chard Junction Pit identified units that were dated to MIS 5b and MIS 5c, MIS 6 and MIS 8 (Brown et al 2008).

Site	*River*	*Terrace*	*Dates (before present)*	*OIS*
Princesshay	Exe	6 (re-worked)	43,000±5,000 44,000±4,000	3 3
Yellowford Farm	Exe	6 (re-worked)	75,000±23,000	5a
Monkey Lane	Otter	7	140,000±20,000	6
Chard	Axe	U	94,000±9,000 98,000±8,000 174,000±18,000 274,000±74,000	5b 5c 6 8
Kilmington	Axe	U	154,000±19,000 179,000±18,000 273,000±26,000 309,000±26,000	6 6 8 9

Table 1: Summary of key Pleistocene terrace deposits and ages in the Exe, Axe and Otter rivers. U: Undifferentiated terrace (after PRoSWeB http://www.personal.rdg.ac.uk/~sgs04rh/SWRivers/arch-mod4.htm)

Investigations undertaken on the gravel terrace system of the River Exe (Brown *et al* 2010) created a chronostratigraphy of the valley's Pleistocene sequence and proposed a new conceptual model for terrace formation. The upper earlier terraces are believed to have been laid down during the Middle Pleistocene while the lowest 4 terraces have been successfully dated to MIS stages 4-2. The authors suggested a conceptual model of how these terraces formed stressing the importance of lateral erosion and the reworking and redeposition of terrace gravels throughout the system. This allowed the authors to re-evaluate the Palaeolithic tools found within these terraces and infer that although they are found with terraces dating to MIS 4 the implements themselves were probably of greater antiquity possibly MIS 6. Moreover the evidence provided by the terrace gravels suggested that the landscape inhabited by Palaeolithic hominins was characterised by wide inter-linking flat gravel covered floodplains and shallow multi-channel rivers of lower relative relief than today's landscape (Brown *et al* 2010, 910).

A synthesis of the available data from museum collections and Sites and Monuments Records (SMRs) for Palaeolithic finds associated with the Pleistocene gravel terraces has enabled a greater understanding of the distribution of Lower and Middle Palaeolithic sites (Wessex Archaeology 1992; Wymer 1995; Wymer 1999). Recent re-examination of sites of the MIS 11 has tried to reconstruct possible occupational patterns of early human populations (Ashton *et al* 2006). The authors focused on sites in southern England which had been interpreted as lacustrine in origin and argued that the presence of human remains was in fact during a period in which the lakes were infilling and becoming part of a fluvial system. Humans did not favour lake-edge situations, as had been thought, but appear to have been exploiting the river valleys which would have offered a greater variety of resources (Ashton *et al* 2006, 503).

These alluvial landscapes appear to have been attractive for settlement due to the variety and wealth of resources (Ashton *et al* 2006), and yet their dynamic nature has meant that the survival of occupation remains has been rather precarious. For example, there are only a few cases of butchery sites or other activity areas that have been identified *in situ* (e.g. Ebbsfleet butchery site, Langford Quarry or Boxgrove); it is more common to find weathered flakes and handaxes reworked into later gravel deposits. Consequently there are two significant problems when trying to analyse the distribution of Palaeolithic sites across the south of England: it is difficult to date the terrace sequences and the artefacts found within them have often lost their spatial and temporal context (Brown 1997, 152; Hosfield 2001, 85; Needham and Macklin 1992, 12).

Gibbard (1985) evaluated the potential use of archaeological material as a proxy dating method for the stratigraphic alluvial units in the Later Pleistocene terraces of the Thames. Limited understanding of the lithic typology rendered it an ineffective dating tool (Gibbard 1985). As an alternative, it is becoming common procedure to adopt multiple age estimation of a variety of materials (including relative dating methods, such as biostratigraphy and artefact assemblages) to allow for greater confidence in the resultant age estimation (Bridgland *et al* 2004).

The dating methods used in establishing geochronologies of the alluvial deposits in which the archaeology is found (eg OSL and radiocarbon methods along with relative dating methods) have their own limitations that often do not permit the identification of the age of sedimentary features at a resolution finer than the MIS scale (eg Hosfield and Chambers 2002; Toms *et al* 2004). While models of terrace formation have been incorporated in the analysis of secondary archaeological data at the MIS level (White 1998; Wymer 1999; Ashton and Lewis 2002) it is often not possible to refine or bracket the timeframe of a depositional unit and therefore answers to high-resolution research questions still remain elusive (Hosfield and Chambers 2004).

In order to recreate the depositional environment in which the artefacts were redeposited, it is essential to understand preservation biases of Pleistocene alluvial units (Gibbard and Lewin 2002; Hosfield and Chambers 2004). Gibbard and Lewin (2002) have suggested, for example, that only specific phases of braided river sedimentation activity will be preserved. This hypothesis is based on modern analogues of active river systems, which suggest that lateral channel shift by bank erosion is both rapid and spatially extensive. This has clear implications for the interpretation of reworked archaeological material (Hosfield and Chambers 2004).

Studies of the Pleistocene river systems in the south of England have contributed to the reconstruction of the Lower and Middle Palaeolithic landscape. An ice age world, once thought of as sparsely inhabited is now understood to have been a complex landscape with many environmental niches offering a range of resources to hominin populations (Schreve *et al* 2002; Ashton *et al* 2006). Recent discoveries of archaeological material in exposures of Pleistocene deposits has allowed for the integration of depositional models taking advantage of refinements of both dating techniques and artefact typologies (Wenban-Smith *et al* 2006; Schreve *et al* 2002; Lewis *et al* 2006).

3. The Holocene

Lewin *et al* (2005) identified four main models which have been proposed to understand Holocene alluviation in Britain; the paraglacial model (Macklin and Lewin 1986; Rose 1995; Ballantyne 2002), the stable bed, aggrading bank (SBAB) model of floodplain evolution (Brown *et al* 1994), the late Holocene flooding and alluviation model (Robinson and Lambrick 1984) and the Holocene episodic activity/preservation model (Macklin and Lewin 1993; 2003).

Some models of floodplain evolution have concentrated on the development of floodplain adaptation to the dramatic climate fluctuations at the end of the last glacial period. The paraglacial model focuses on the reworking of glacial and periglacial materials by fluvial activity in the context of increasing vegetation cover, ameliorating climate and rising sea level. The SBAB model of floodplain evolution proposes that during the early Holocene multi-channel braided systems stabilized with the narrowing and deepening of some channels, and the progressive abandonment of others over the course of the Holocene (Brown *et al* 1994).

Other models have focussed on the increase of sediment delivery during the later Holocene that has been attested in many systems across the UK. Robinson and Lambrick (1984) proposed a late Holocene flooding and alluviation model which argued that the episodic flooding and alluviation of the later Holocene can be largely restricted to the last 3000 years. They also cited anthropogenic activity as the driving force that induced widespread deposition of fine sediments on top of Pleistocene floodplain gravels. Subsequent work has demonstrated that not only is the Holocene sequence more complex but that in many cases the lower gravels are at times much later in date than had been previously thought (Lewin *et al* 2005). Macklin and Lewin (1993; 2003) have proposed a Holocene episodic activity/preservation model which identified the existence of major but probably brief periods of alluviation during the Holocene which they stressed relate to both climatic episodes as well as to anthropogenic factors. The role of preservation biases and the spatial and temporal bias in the alluvial record is emphasised as well as anthropogenic factors leading to enhancement of the available sediment for entrainment during the later Holocene (Coulthard and Macklin 2001).

A recent review of radiocarbon-dated Holocene fluvial deposits in the UK, suggests that the lowland river systems in both the south and east of England experienced up to twenty flooding episodes between 11,190 and 390 cal BP (Johnstone *et al* 2006, table 2). Six of these episodes have been correlated to changing environmental conditions and in particular to large-scale variations in climate (Johnstone *et al* 2006). The authors note that one explanation for the variable fluvial behaviour is the impact of anthropogenic land use change in the mid-late Holocene (c. 4250 – c. 2050 cal BP) which would have increased the available runoff and sediment supply and made river basin sedimentation considerably more responsive to changes in climate (Macklin and Lewin 2003; Johnstone *et al* 2006)(Figure 5).

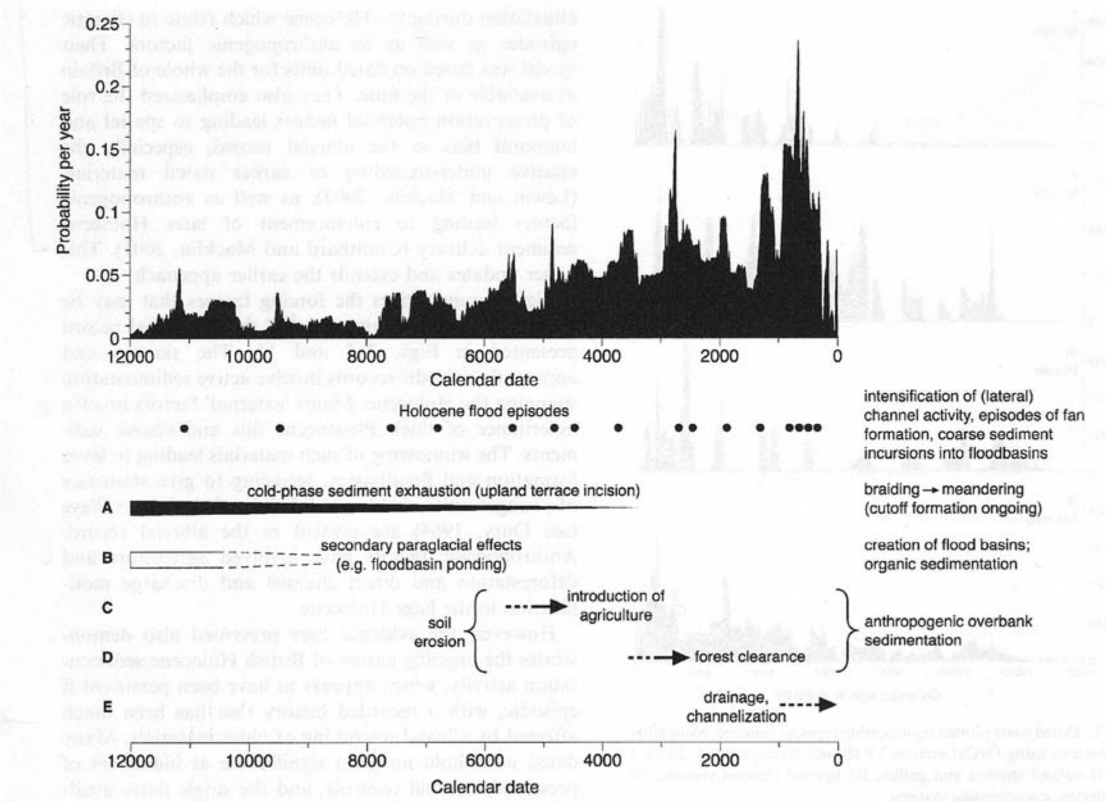

Figure 5: Summary diagram of British Holocene alluviation forcing factors. (Lewin et al 2005)

Typically the Holocene alluvial sequence for southern England is composed of fine overbank silts and clays that sit on coarser Pleistocene deposits. Lowlands and abandoned palaeochannels are commonly infilled with organic deposits (peats and organic silts) which tend to be associated with mid to later Holocene climatic fluctuations. Recent studies have also highlighted the influence of catchment scale constraints on the depositional histories of different lowland valleys (Thorndycraft *et al* 2004; Ellis *et al* 2003, Collins *et al* 2006). One of these catchment scale constraints is the effect of land use regimes. Modelling of an upland catchment has demonstrated the direct relationship between increased sedimentation and tree removal (Coulthard and Macklin 2001). A number of studies in southern England have reported a clear change in sediment type whereby organic rich silts and clays are succeeded by inorganic alluvium around 2500 cal BP which could indicate the increased effect of long-term land use on catchments (Shotton 1978; Brown and Barber 1985; Smyth and Jennings 1990; Brown and Keough 1992; Parker and Robinson 2003; Smith *et al* 2005; Foulds and Macklin 2006; Macklin *et al* 2005; Johnstone *et al* 2006; Macklin and Lewin 2003). These flooding events were immediately preceded by major agricultural innovations in Britain with the adoption of iron implements that could have increased runoff and erosion resulting in enhanced flood-related sedimentation (Macklin *et al* 2005).

3.1 The South East

Two key factors have influenced the formation and preservation of the archaeological record on the floodplain archaeology of the Lower Thames valley. The location of London has meant that the riverbank has been the focus of occupation and development since Roman times as the city grew in importance and size. The continued process of urbanisation in London and the regulations set out by PPG16 (Sidell 2003b,136) has increased the amount of developer funded archaeological projects which has in turn greatly increased the amount of archaeology that has been exposed and documented. A series of excavation "windows" has also enabled greater visibility and understanding of the development of the past alluvial landscape of the Lower Thames (Rackham and Sidell 2000).

The second factor that has greatly affected the occupation and the preservation of the archaeological record of the Lower Thames valley is postglacial sea level change. The Lower Thames saw a rise of about 15m in relative sea level between c. 10,000 and c. 6000 BP (Rackham and Sidell 2000; Sidell 2003b). This would have had a significant effect upon settlement of the outer and mid estuary floodplain. It has been suggested, for example, that settlement areas along the river margin progressively moved to higher ground as the land below was overtaken by the rising water levels (Rackham and Sidell 2000).

A review of the evidence for river levels in central London (Milne *et al* 1983) concluded that in the 1st century AD, the Thames was tidal approximately to the London Bridge. Recent investigations associated with the Jubilee Line extension have suggested instead that the tidal head had migrated beyond Westminster by at least 1200 cal BC (Sidell *et al* 2000; Sidell 2003b,140). From the 1st to the 4th centuries AD the water level may have dropped by as much as 1.5m. In Medieval times river levels began to rise again (from the end of the 12th century) and show a gradual but continual rise which is continuing to the present day (Rackham and Sidell 2000) (Figures 6 and 7).

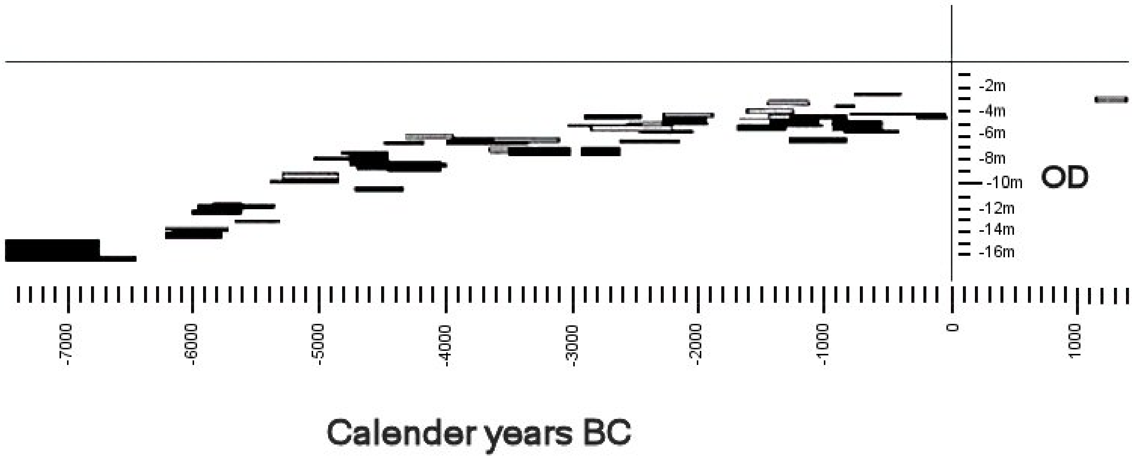

Figure 6: Curve of the relative sea level rise in the Thames Valley. (Sidell 2003a)

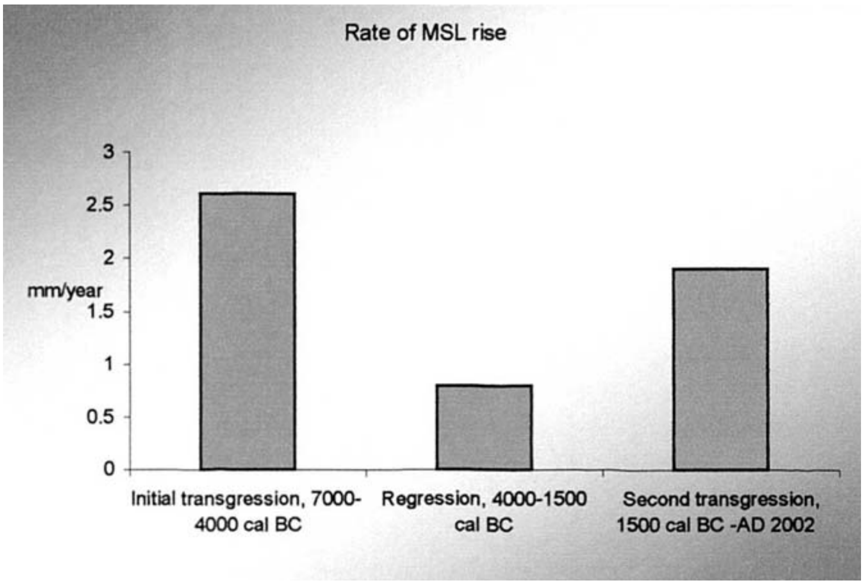

Figure 7: The tripartite scheme of the rise and rates of rise of Holocene Mean Sea Level (MSL) in the Thames Valley (Sidell 2003a)

Some of the most significant Upper Palaeolithic and Mesolithic sites have been discovered on the upper surface of the gravel terraces of the Lower Thames and its tributaries, the Colne and Kennet valleys. Throughout southern England, early Holocene deposits of organic clays and peats which seal prehistoric deposits have been recorded (Lewis *et al* 1992; Collins *et al* 2006, Gibbard 1985; Burrin and Scaife 1984). The extent of these deposits has yet to be systematically mapped but preliminary interpretations of the organic clays with a high concentration of comminuted charcoal and peat deposits has included Mesolithic activity (ie a possible early use of fire for forest clearance or damming of rivers) (Lewis *et al* 1992: 245; Collins *et al* 2006: 127). One such site is Three Ways Warf, Uxbridge where flint and bone scatters sealed beneath alluvial silts date to the Late Upper Palaeolithic (Lewis *et al* 1992).

Three Ways Wharf is located on a major tributary of the Thames, the Colne Valley, near Uxbridge. The site has a sequence of deposits ranging from the Late Glacial to the Mesolithic and remains one of the few examples of this transitional period. Scatters of flints and faunal remains were discovered on a low bar or 'island' within a possibly braided river system (Lewis *et al* 1992, 239). Micromorphological analysis of the profile suggested that the island had been above the water level long enough to develop a mature soil profile prior to occupation. The site was subsequently abandoned due to a rise in the water table seen in the subsequent formation of a sedge swamp (Lewis *et al* 1992). Swamp formation is thought to have been initiated by a rise in river base level caused by rising sea levels reflected in the formation of the organic clay which overlies the Mesolithic deposits (Lewis *et al* 1992: 244). Recently, a continuation of the deposit and archaeology has been uncovered at the Sanderson site, a few hundred metres away (Sidell J pers comm).

A series of sites in the Kennet Valley indicate the presence of Mesolithic groups during the 11th – 7th millennia BP (Ellis *et al* 2003). The recently published Faraday Road site documents an *in situ* Mesolithic occupation located on the floodplain about 200m north of the River Kennet. An assemblage of Mesolithic worked flint, was discovered with burnt unworked flint, animal bone, nuts and charcoal which suggests a possible hearth (Ellis *et al* 2003). The environmental evidence from the deposit indicated that the Faraday Road site was occupied on the seasonally dry floodplain. Prior to the Mesolithic, the floodplain was dissected by a series of ephemeral channels that were gradually infilled with calcareous alluvium. During the Mesolithic, the site is likely to have been situated on a tussocky grassland floodplain which bordered a reed swamp or fen carr at the river's edge with a tendency for seasonal flooding (Ellis *et al* 2003: 129). Increased flooding documented in this period suggests that the site was located closer to the river, rather than any significant climatic fluctuation (Ellis *et al* 2003). Regardless of the cause, abandonment of the site seems to have been prompted by the onset of locally wetter habitats.

Another important aspect of this site is the survival of a buried Mesolithic soil. It exhibited effects of bioturbation, but still preserved an intact topsoil (Ah) and a underlying (Bw) horizon (Ellis *et al* 2003, 123). Samples of bone and a charred hazelnut from the occupation deposit have been successfully dated. Although they both fall within the Mesolithic period (bone 9418 +/- 60; hazelnut 8510 +/- 60 BP), there appears to be a thousand year between their deposition (Ellis *et al* 2003, 127). This is not exceptional considering that the soil profile appears to have been bioturbated, however it does have consequences for our ability to interpret the occupational history of the site.

Some of the earliest dates for Holocene alluviation come from the south of England in the Sussex Ouse. Burrin and Scaife (1984) suggested that increased sedimentation was linked to vegetation disturbance by Mesolithic communities. Recently these conclusions have been questioned as a response to the reinterpretation of the palynological evidence and the lack of directly datable valley fills (Foulds and Macklin 2006).

During the early Holocene the Lower Thames floodplain was a complex environment of peat-forming areas, migrating channels and raised eyots (Sidell 2003a). Often these eyots were the focus of prehistoric occupation, for example Runnymede (Needham 1991; 1992), Westminster, Southwark (Bowsher 1991; Dillion *et al* 1991; Merriman 1992) and Bermondsey (Sidell *et al* 2002). These areas tended to lie at the junction between the higher ground on the edge of an island and the adjacent peat and alluvium, which preserved the evidence of human activity that took place when the river levels were lower (Merriman 1992; Sidell *et al* 2002). The investigations carried out for the Jubilee Line extension have suggested that the sand eyots of Westminster and north Southwark did not complete their formation by the early Holocene as originally believed but rather they formed in the mid-Neolithic (c. 3500 cal BC). This could help explain why there is a lack of Early Neolithic occupation in the floodplain (Sidell 2003b).

Models of the early Holocene floodplain of the stretch of the Thames River between Southwark and Lambeth have been built, from borehole and other data that represent the interface of gravel and overlying strata (Figure 8) (Fig. 5 Sidell *et al* 2002:8). These models illustrate how this stretch of the river has migrated northward significantly since the Early Holocene. It is believed that the multiple channel morphology was due to the restricted seasonal discharge into the Upper Thames resulting from the decrease in spring meltwaters following the decay of the Devensian ice sheets (Sidell *et al* 2002). Pollen evidence from peat deposits dated to this period have indicated that the river would have been fringed with a birch and pine woodland, which provided shelter for species such as *Cervus elaphus* (red deer) and *Bos primigenius* (aurochs) (Sidell *et al* 2002, 9).

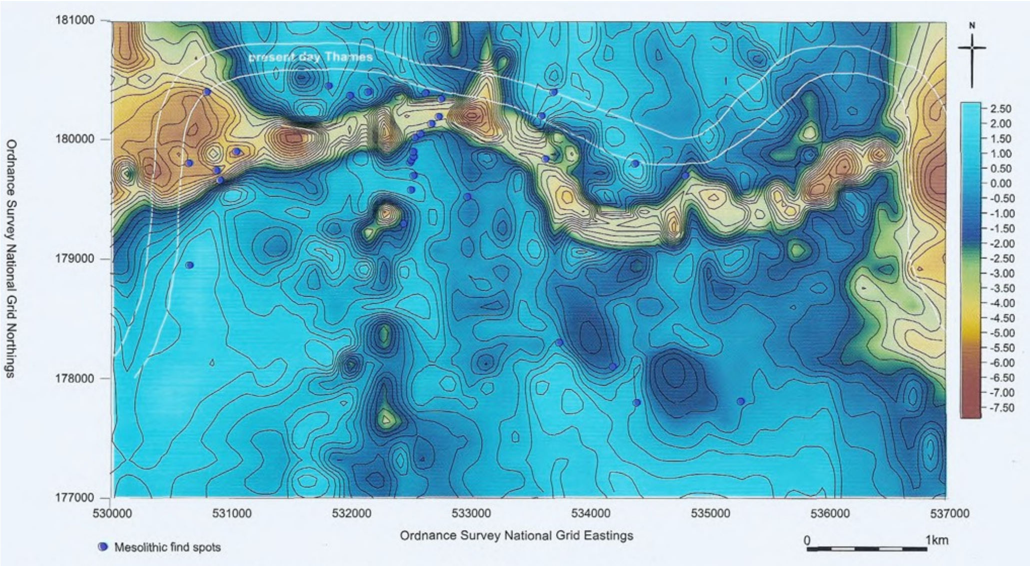

Figure 8: Model of Late Mesolithic Southwark/Lambeth floodplain with find spots. Scale1:50,000 (Sidell et al 2002)

While the period of 5000-2500 cal BC has been identified as one of estuary contraction (Long *et al* 2000) which saw the reduction in the rate of relative sea-level rise and an expansion of the peat lands into the floodplain, there are sedimentary events documented in the sequences of Union Street and Joan Street indicating inundation by estuarine waters in the 3rd millennium cal BC. These appear to have been isolated events and it was not until c. 1100 cal BC that the permanent positioning of the tidal head on the Southwark/Lambeth stretch of the Thames submerged the peat horizons that formed during the preceding period of estuary contraction (Sidell *et al* 2002). The sequence from Union Street, and especially the diatom evidence, suggests that rather than the tidal head continuing to migrate further upstream in the late 2nd and into the 1st millennium cal BC, the marine influence declined in this area (Sidell *et al* 2002). There is only limited data available on the river and environmental development during the 1st millennium cal BC so it is possible that the trend of downstream tidal head migration and concurrent peat formation continued into the Roman period.

In east London a series of Bronze Age trackways and associated timber structures have been found within substantial peat horizons, but generally towards the upper contact where the alder carr peats have been submerged by riverine sediment (Rackham and Sidell 2000, 23; Meddens 1996 and references therein). Several of the trackways have produced ^{14}C dates from the middle Bronze Age and it has been suggested that the structures and trackways were used to access summer pasture along the marsh edge (Meddens 1996). The recent discovery that the tidal head was beyond Westminster by at least 1200 cal BC is not only much earlier than had previously been thought, but since this was also recorded in sediments at c. -0.5m OD, the river level was higher than had been previously believed (Sidell 2003b). This has implications for our understanding of the distribution of the trackways and other structures such as the possible Bronze Age platform at Vauxhall (Haughey 1999; 2003). They may have been built in response to rising river levels and decreasing land availability. Rising relative river levels are likely to have played a significant role in the abandonment of previously important areas such as the field systems on low lying sand islands around Tower Bridge (Sidell 2003b; Sidell *et al* 2002).

Pollen evidence from some sites in the Lower Thames valley has supported the hypothesis of deforestation and intensification of arable agriculture in the middle Bronze Age (Meddens 1996). The coincidence of possible intensification of marsh use with a shift in dominant vegetation type suggests a link between agricultural intensification and increased wetland exploitation during the middle Bronze Age. It has been suggested that this apparent change showing increased grasses and cereals at the cost of tree pollen could indicate arable agriculture being intensified or carried out closer to the Bronze Age settlements on the Thames edge (Scaife 1991, cited in Rackham and Sidell 2000). Pollen evidence for cereal cultivation in the London area comes from sites such as Wilson's Wharf, the Southwark Leisure Centre by the Elephant and Castle and the site of Stamford Street which has an organic sequence dating from 1670-1515c cal BC to 980-830 cal BC. Ard marks attesting to Bronze Age agricultural practices on the sand eyots and floodplain have also been found on the lower sand deposits at the sites of Joan Street and Union Street, Phoenix Wharf, Wolsey Street, Lafone Street which has ard marks dated to 1520-1220 cal BC (Bates and Minkin 1999, cited in Sidell *et al* 2002). It appears that there was a reduction in exploitation of the wetlands in the late Bronze Age; this may be related to increased wetness, since there is evidence from elsewhere in Britain suggesting a possible climatic deterioration, with increased rainfall and lower temperatures at this time (Macklin *et al* 1992,135).

The Holocene sequence from the Kennet River, from the site at Woolhampton, has suggested that there was an increase in flooding events during the middle Holocene. The final episode of inorganic deposition correlates with a regional change in fluvial regime beginning in the Iron Age (e.g. Robinson and Lambrick 1984; Sidell *et al* 2000). There may well have been a link with the expansion of pastoral and arable agriculture as for the Severn (Brown and Barber 1985), which would have increased the potential sensitivity of the catchment systems to climate change (Macklin and Lewin 1993; 2003; Collins *et al* 2006,130).

Other forms of archaeological evidence come from the waters of the Thames itself and are thought to have been ritually deposited in the river: skulls, stone axes, weapons, the Iron Age helmet from Waterloo and the shield from Battersea. The large number of skulls that have come from the dredging of the Thames over the years (ca. 300) have at times been found in association with prehistoric artefacts and weaponry but rarely with other human remains. There seems to be an emphasis on male skulls (140 male: 92 female), with a bias towards individuals aged between 25-35 (Bradley and Gordon 1988). The skulls tend to date from the Later Bronze – Iron Age to the Roman period (Bradley and Gordon 1988), a period in which inhumation burials are rare and for which the mortuary practices are poorly understood. This had led to hypotheses of deliberate funerary river deposition of certain members of the population (Bradley and Gordon 1988). Moreover, there is a current consensus that most of the weaponry from the Thames was originally deposited there for votive and ritual reasons (Needham and Burgess 1980: 449)

The increasing urbanisation of the city of London from the Roman period on tends to dominate the archaeological record and therefore compromises the survival of undisturbed sediment dating to prehistoric periods (Rackham and Sidell 2000). The information available for the Roman period itself tends to be related to areas on the waterfront, for example the channel revetments from Guy's Hospital in Southwark (Mills and Whittaker 1991). Later evidence of occupation near the river's edge comes in the form of medieval fish traps, the remains of a Tudor jetty at Greenwich, and a 17th century river stair at Trig Lane in the City (Milne *et al* 1997).

3.2 The Solent and South West

Studies of the evolution of the Solent suggest the river system migrated south in response to asymmetry of the basin and intermittent isostatic adjustment during the Pleistocene (Velegrakis *et al* 1999). Migration of the system would have resulted in the extensive scouring of the previous channels and their floodplain deposits. Prior to sea level rise, the landscape in the west Solent would have been free from major erosive forces during the early part of the Holocene. This has allowed the preservation of submerged estuarine deposits and in some instances their associated archaeological sites (eg. Yarmouth, Bouldner Cliff) (Momber 2000).

Like the rest of the south, the south-west of England was beyond the extent of glacial activity during the Last Glacial Maximum. There is however documented evidence for the extension of the Irish Ice Sheet in the Irish Sea southward to the Scilly Isles (Scourse 1986). The hydrology of the area was greatly affected by fluctuating sea level, most markedly felt in the Severn Estuary. The changing coastline and frequent inundations created fen-like areas known as the Somerset Levels. Rising sea levels also reduced river gradients which led to alterations in river bedform. By the beginning of the Neolithic, in common with most lowland rivers in north-west Europe, rivers in the South West had evolved meandering or anastomosing bedforms (Brown 1997, 210). There is little evidence for channel migration or indeed deposition of fine- grained sediments on floodplains during the Neolithic and much of the Bronze Age; this has been attributed to the stabilising influence of the alder and hazel woodland, combined with a less seasonal flood regime than that seen at present (Brown 1997, 210).

Unlike the south-east of England, one of the major contributing factors to our lack of knowledge is that low level of development along the major rivers which has lead to fewer archaeological investigations. On the one hand this has allowed for the preservation of long sequences, but it has also meant that the published information is limited for this area.

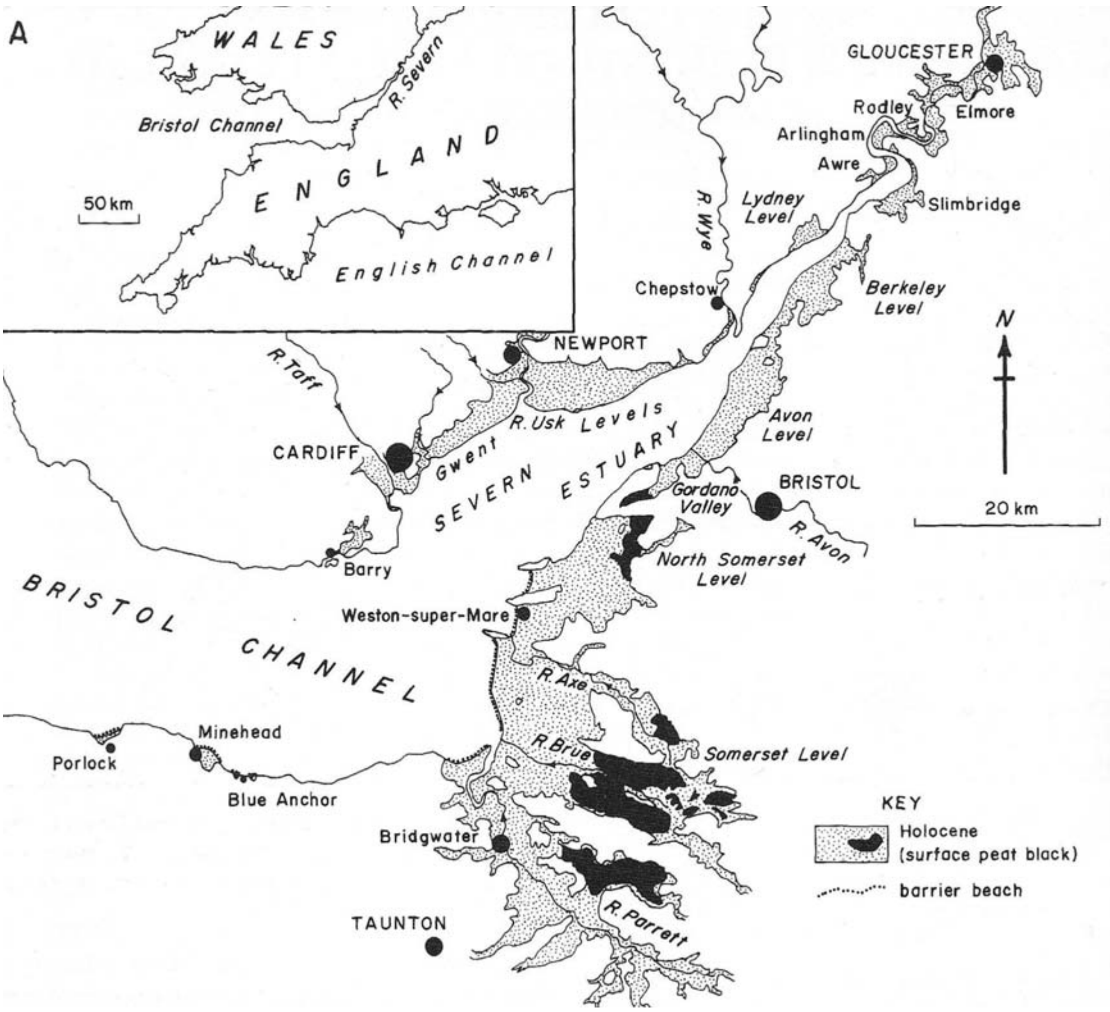

Figure 9: The Severn Estuary Levels. A. Setting in southwest Britain. B. Severn Estuary Levels. (Allen 2000)

The exception is the region surrounding the Severn Estuary, which, like that of the Thames Estuary, is rich in sedimentological evidence recording environmental change since the Last Glacial Maximum (Figure 9). Fluctuating sea level and the repeated marine transgressions of the low lying areas surrounding the Severn Valley and Bristol Channel has led to the creation a series of intertidal peats reflecting periods of past marshland which offered human populations the opportunity to exploit wetland ecologies throughout the mid to late Holocene. The area of the Severn Estuary, therefore, has been the centre of much alluvial geoarchaeological research. In particular the Rapid Costal Zone Assessment Report should be consulted for more detail on the palaeoenvironmental evidence for Holocene sea level change (Brunning 2008: 44-56). The mean annual temperature in the area of the Severn Estuary rose by approximately 15°C during the period from the last glacial maximum (c. 19-23 ka) to the initiation of the Holocene (c.10.5 ka) (Bell and Walker 1992). The Severn Estuary and the Bristol Channel were rapidly transgressed by the sea after about 11 ka as a result of the release of meltwater from receding glaciers and a global eustatic sea-level rise of as much as 130-135m (Allen 2000 and references therein). With the reduction in the rate of Holocene sea level rise there was a period of estuary contraction from around 6000- 3000 BP in the Severn, Thames and Solent (Long *et al* 2000). The vulnerability of the low lying areas surrounding the estuary to changes in sea level during this period can be read in the sedimentary record that typically shows a series of soils and intertidal peats interrupted by marine inundations giving rise to alternating peat-clay sequences often developed on head or till. Generally, the Holocene sediments of the Severn Estuary levels are composed chiefly of silts, representing intertidal mudflats and mineralogenic salt marshes which alternate with peats which mantle the underlying rock and a variety of Pleistocene glacial fluvial and littoral deposits (Bell 2000; Allen 2000). Going inland, away from the influence of the coast and river, the silts tend to thin and the peats to thicken for a variety of different environmental factors (Allen 1995).

One of the earliest of these sequences is reported on head below the submerged forest at Porlock where there are 5 peat bands that date between 8300-5500 cal BP (Jennings *et al* 1998). A number of Mesolithic sites are known to have been submerged, for example at Porlock (Jennings *et al* 1998) and Goldcliff (Gwent levels) (Bell *et al* 2000) and Westward Ho! (Balaam *et al* 1987). At Westward Ho! a Mesolithic shell midden dated to c. 5450 cal BC (Balaam *et al* 1987) was discovered along with an extensive artefact and charcoal scatter overlying a silty clay of marine origin. It has been suggested that the site was waterlogged at the time of occupation with faunal material indicating that aurochsen, red deer, roe deer, pig and fish were exploited. Molluscan evidence in the midden represents the exploitation of a rocky, sandy and muddy coast. Several of the inundated Mesolithic sites seem to have been originally located close to the shore. It has been suggested that the presence (and quantity) of charcoal at a number of these sites could be either derived from local campfires or even the deliberate modification at the coastal woodland edge (Bell 2000).

There is a series of Levels along the southern bank of the Severn estuary which have Holocene deposits of archaeological significance (Figure 9). The Levels at Elmorfe-Logney, Rodley, Arlingham, Awre and Slimbridge have similar mid Holocene peat sequences demonstrating considerable channel instability as well as early embanking (Allen 1986; 1990; Allen and Fulford 1990a; 1990b; Hewlett and Birnie 1996). In the Vale of Gordano, at the southwestern end of the Avon Levels, there is a Holocene sequence of mainly estuarine silts with peats resting on either gravel or bedrock (Insole 1997). Due to the position of the site behind a sand 'barrier' it was protected from the coast which has enabled the preservation of a particularly long peat sequence beginning in the early Holocene and continuing until at least 4580-4440 cal BC (Brunning 2008 and references therein). There are other isolated outcrops of Holocene estuarine silts and peats documented at Blue Anchor, Minehead, Porlock , the Parrett valley and along the Brue and Axe valleys (Jennings *et al* 1998; Allen 2000; Brunning 2008 and references therein).

Two main phases of activity have been identified in the intertidal deposits; later Mesolithic and middle Bronze Age to middle Iron Age (Bell 2000). During these periods the strip of coastal wetland would have offered particular ecological opportunities which would have made it attractive for occupation or activity. However, these sedimentary environments have favoured the preservation of sites from these phases while other periods, which may have seen similar levels of activity, have not been preserved (Bell

2000). In the Severn and its tributaries there is increased alluviation from the late Bronze Age (Shotton 1978: 31) up to five times modern levels in the lower Severn between 1000-0 cal. BC/AD (Brown 1987). According to Bell and Neumann, a direct causal link to anthropogenically related increases in sediment supply in the catchment seems unlikely given the evidence of desiccation, together with the geographical scale and magnitude of the inundation. The authors instead feel that a rise in relative sea level or increased storminess would be more likely causal factors (Bell and Neumann 1997).

The archaeology of the Somerset Levels has been intensively studied. Extensive peat cutting has uncovered artefacts and trackways that have given increasing insight into the occupation of this marshland in prehistory (Coles and Coles 1980; Coles and Coles 1986). The large body of literature generated from the continued study of the Levels is contained in the *Somerset Levels Papers* as well as in specialist papers in journals and chapters in books (for example, Housley *et al* 2007). For a concise summary of the palaeoenvironmental work undertaken to date please refer to the South West Area Regional Framework document (Webster 2008).

The region encompasses the low-lying peat moors that are interrupted by numerous islands of sand and rock. The moor is bordered to the east and west by the Mendip and Quantock hills and is watered by the Axe, Brue and Parret (Rippon 1997). At the beginning of the Holocene, the valley that drained this area was underwater due to the post glacial sea level rise, the only dry land being occasional sand islands or the limestone ridge of the Polden hills. In Somerset, marine inundation occurred in the Axe River valley as far as Glastonbury, between 1200-900 and 800-470 cal BC (Housley 1988: 82). This drowned valley was then covered by silt and clays laid down by the seawaters and interleaved with thin lenses of peat which formed during temporary lowering of the sea level (Coles and Coles 1980; Coles and Coles 1986).

By c. 4500 BC the sea had retreated from the levels, creating a swampy estuarine area colonised by reeds, which eventually created a first layer of peat over the marine clay. The continuous accumulation of peat raised the ground level over the water level to create a fen woodland by 3500 BC. It was previously thought that peat growth in the central Brue valley and in the Sedgemoor wetlands had stopped around AD 400 (e.g. Coles 1989, Godwin 1981) but has recently been documented to have continued into the Medieval and, in places, post Medieval times (Brown *et al* 2003 cited in Housley *et al* 2007). Archaeologically there is evidence of Palaeolithic to Iron Age occupation, the earliest periods representing hunter-gatherers with sporadic finds found embedded within the peat (Coles and Coles 1986). Later occupation of the levels is represented first in the Neolithic with a series of trackways traversing the marshland which have been associated with farming communities (4000 BC). The most famous of these, Sweet Track, has produced radiocarbon dates of 3806 BC (early Neolithic). There have been uncovered the remaining segments of a series of these trackways spanning the Neolithic and Bronze Age, for example Walton Heath Hurdles, and Abbot's Way. Both were constructed roadways, one made of woven panels or hurdles and the other of timber planks that were placed over the surface of the raised bog, laid down on a surface where open pools of water, wet hollows or drier hummocks created an uneven route across the moor. Individual lost or deposited artefacts are often discovered alongside these trackways.

Settlement on the wetland itself begins only in the Iron Age with the establishment of Glastonbury and Meare in the 3rd century BC (Coles 1987; 246; Coles and Minnitt 1995,178). Glastonbury Lake Village was built in the marsh, probably close to the bend in the river. Meare Lake Village is similar in structure and layout but on a smaller scale. Abandonment of the settlements at Glastonbury and Meare has been linked with declining environmental conditions (Coles and Coles 1980: 54). The evidence for the prehistoric occupation of the levels comes to an abrupt end and in AD 250, when a great transgression from the sea brought marine water and silts and clays onto the western margins of the raised bog. In later periods, from the Roman times onward, the landscape of the Severn Estuary was further modified by extensive drainage and the making of seawalls and embankments (Allen and Fulford 1986; 1987; Fulford *et al* 1994; Rippon 1996; 1997; Brunning 2008 and references therein).

4. Mining and Metalliferous Sedimentation

In recent years the geochemical analysis of alluvial and estuarine sediments has been helping the reconstruction of tin mining practices in south west England from the Bronze Age to the mid 19th century (Macklin 1985; Macklin *et al* 1994; Pirrie *et al* 2002; Thorndycraft *et al* 2004). One of the principal tin minerals exploited was cassiterite (SnO_2) which was found in large quantities in the alluvial gravels weathered from the local granite outcrops. During tin streaming the coarse gravels are "washed" in order to separate the denser, coarse particles from the finer material which will contain small grains of heavy minerals from the original weathered granite. Therefore the main environmental impact of tin streaming was the large increase in sediment supply to the local rivers, at times leading to the silting up of ports in Devon and Cornwall (Thorndycraft *et al* 2004; Pirrie *et al* 2002). As early as AD 1531 an Act of Parliament introduced pollution legislation in south-west England in order to limit the large quantities of sediment entering the estuaries (Greeves 1981). The geochemical analysis of mining-contaminated floodplain sediments has therefore been used to correlate phases of aggradation with the known historical record of mining within the catchment (e.g., Davies and Lewin 1974; Lewin *et al* 1977; Macklin and Lewin 1989; Macklin *et al* 1992; Leigh 1994; Hindel *et al* 1996).

Macklin (1985) successfully established the impact of historical metal mining on the River Axe, as recorded on the floodplain immediately downstream of the Mendip Hills. He was able to prove that the river basin had been extensively affected by lead/zinc mineralization. The high levels of contamination and the phases of maximum accumulation were moreover linked to mining that has taken place in the hills since the Roman Period if not before (Macklin 1985). This was done through the investigation of the heavy metal chemistry of floodplain sediments in the upper Axe Valley. From the high levels of heavy metals at the base of the fine-grained alluvium, it became apparent that metal mining introduced episodically fine, metalliferous sediment to the River Axe (Macklin 1985). By analysing heavy metal concentration in the alluvial sediments, floodplain development and sedimentation of overbank fines were examined for a period approaching 300 years of deposition. This time frame is elusive to traditional means of dating, therefore the heavy metal concentrations in alluvium were correlated with documented episodes of mining in the catchment. In this way the floodplain sediments were dated and rates of sedimentation were determined over an extended period (Macklin 1985).

In Devon, the Teign and Erme valleys along with Taw Marsh and the Avon Valley were investigated using sediment analysis, specifically geochemical analysis to reconstruct the alluvial response to tin streaming in these catchments (Thorndycraft *et al* 1999; 2003; 2004) (Figure 10). The Erme alluvial record indicates that late Roman or early Post-Roman tin streaming occurred within the catchment between the 4th and 7th centuries AD causing aggradation of sediments enriched with Sn on the floodplain. Aggradation also occurred in the lower Avon Valley around 1448 – 1621 cal. AD (SRR-6224). This coincides with a known peak in tin mining activity during the 16th century (Thorndycraft *et al* 1999), and probably predates the Little Ice Age (Thorndycraft *et al* 2003).

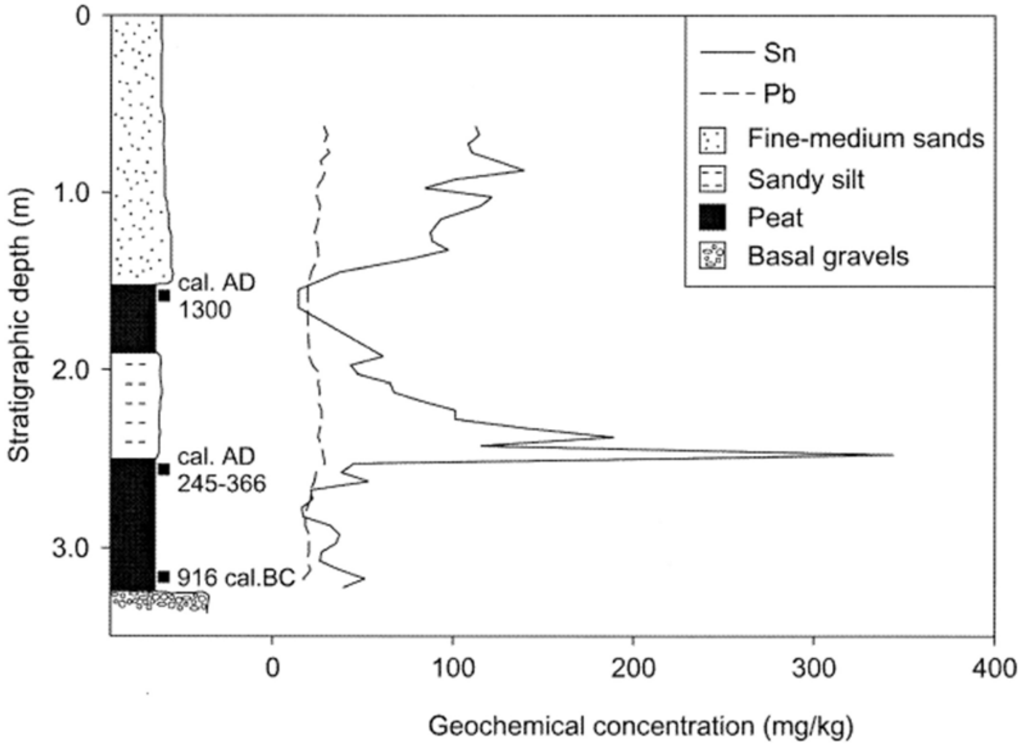

Figure 10: Erme Valley palaeochannel stratigraphy (Thorndycraft et al 2004)

In Cornwall several estuaries have been analysed for similar geochemical signals and correlated to documented historic mining activity (Pirrie *et al* 2002). The Fowey, the Gannel and Camel Estuaries have all recorded phases of sedimentation with clearly defined geochemical anomalies in the intertidal estuary sediments attributable to tin streaming possibly prior to 1880 (Macklin *et al* 1994, Pirrie *et al* 1997; 1999; 2000; 2002).

5. Conclusions

The field of alluvial geoarchaeology has experienced a great florescence in the last twenty-five years. The nature of the lowland river systems of the south of England has provided an ideal context for the development of major research projects that have investigated long-term landscape histories of alluvial environments. This review has attempted to identify not only a number of the key research projects but also the variety of approaches that have been applied, their most significant results and the key themes and research questions that have been raised during the course of these projects.

Continued pressure for urban development in the south-east has produced an ever increasing number of exposures of early Pleistocene deposits. These exposures have furthered our understanding of Lower and Middle Palaeolithic landscape evolution (Schreve *et al* 2002; Wenban-Smith 2006). Developer funded archaeological investigations in and around London have afforded us a great opportunity to expand our environmental work in alluvial contexts. The resultant environmental data is enabling us to enhance our understanding of the prehistoric landscape of the Lower Thames valley (Merriman 1992; Sidell 2003b). Hopefully, refinement of dating technologies and our understanding of alluvial behaviour will enable us to expand the range of answers available to high-resolution archaeological questions.

The evolution of general models of alluvial behaviour has been one of the most influential aspects on recent archaeological investigations in alluvial deposits. It is no longer feasible for archaeological research to be undertaken without a clear geoarchaeological strategy. It is only within interdisciplinary research frameworks that substantial advances are made in our understanding of Pleistocene and later Holocene landscape dynamics and the role of humans within them. The pressures from urban development and ever-dwindling research resources make the adoption of appropriate scientific methods essential.

Much of the information summarised in this paper has been generated by projects funded by the Aggregates Levy Sustainability Fund (ALSF) which was introduced in April 2002 and has run for three rounds of funding. This levy on new aggregate extraction has funded a series of projects which focussed on the areas affected by aggregate extraction, their Quaternary deposits and the archaeology within them. As a result there has been new attention given to understanding the development of Pleistocene riverine landscapes as well as assessing the impact on the archaeological record in the major alluvial catchments in the UK. At the time of writing this paper the initial publications of the first two rounds of funding were just beginning to be published while much is still being produced. There are several projects which should be part of this summary but have not yet been extensively published, for example, the larger projects already mentioned, the Palaeolithic Rivers of South-West Britain (University of Exeter), Archaeological Potential of Secondary Contexts (Reading University), the Medway Valley Palaeolithic Project (Southampton University), along with others such as the Submerged Palaeo-Arun & Solent Rivers: Reconstruction of Prehistoric Landscapes, (Imperial College), and the Mapping the sub-surface drift geology of Greater London gravel extraction areas (Lea Valley) (MoLAS), the Palaeolithic Archaeology of the Sussex/Hampshire Coastal Corridor (University of Wales, Lampeter), to name but a few. These projects will all provide information on the dating of key terraces and landforms which will help our understanding of the changing landscape of the river valleys of southern England.

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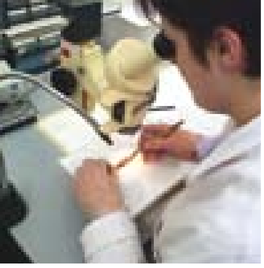
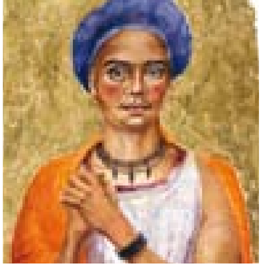
Palaeolithic Archaeology of the Sussex/Hampshire Coastal Corridor (University of Wales, Lampeter) http://www.soton.ac.uk/~ffws/New_ffws/pashcc.html



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