The Palaeolithic occupation of Europe as revealed by evidence from the rivers: data from IGCP 449

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ABSTRACT: IGCP 449 (2000–2004), seeking to correlate fluvial records globally, has compiled a dataset of archaeological records from Pleistocene fluvial sequences. Many terrace sequences can now be reliably dated and correlated with marine oxygen isotope stages (MIS), allowing potentially useful patterns in artefact distribution to be recognised. This review, based on evidence from northwest European and German sequences (Thames, Somme, Ilm, Neckar and Wipper), makes wider comparisons with rivers further east, particularly the Vltava, and with southern Europe, especially Iberia. The northwest and southern areas have early assemblages dominated by handaxes, in contrast with flake-core industries in Germany and further east. Fluvial sequences can provide frameworks for correlation, based on markers within the Palaeolithic record. In northwest Europe the first appearance of artefacts in terrace staircases, the earliest such marker, dates from the mid–late Cromerian Complex. Flake-core industries may have significantly preceded handaxe industries in southern Europe. An important technological innovation—Levallois technique—occurs at the Lower-Middle Palaeolithic boundary, correlated with MIS 9–8. Humans deserted northern Europe during MIS 6, apparently returning to central Germany and northern France (Somme valley) by MIS 5e but not reaching southern England until the appearance of Mousterian culture during MIS 4–3.

KEYWORDS: Palaeolithic; fluvial; river terrace; Thames; Somme.

Introduction

In northwest Europe, where some of the best-known studies of river terrace sequences have been carried out, Pleistocene fluviatile deposits are an important repository for Palaeolithic artefacts, from which a record of early human occupation can be reconstructed. Indeed, in Britain and on the adjacent European mainland, river terrace deposits have provided much of the evidence for the presence of Lower Palaeolithic hunter-gatherers (Wymer, 1968, 1988, 1999; Roebroeks and van Kolfschoten, 1995). This is also true of fluvial sequences in central and southern Europe, the Near East, the Middle East and parts of Asia and Africa, although the data from these regions are patchy (e.g. Bar-Yosef, 1998).

The importance of Palaeolithic artefact assemblages from fluvial sequences is well established, syntheses having been compiled for the Thames (Wymer, 1968, 1999), Somme (Tuffreau and Antoine, 1995) and several rivers in Iberia (Santonja and Villa, 1990; Raposo and Santonja, 1995). In Britain the importance of such fluvial records was acknowledged in the funding by English Heritage of the 'Southern Rivers Palaeolithic Project' (1991–94) and 'the English Rivers Palaeolithic Survey' (1994–97), the results from both being summarised by Wymer (1999). This outstanding piece of work proved to be John Wymer's last major project and will remain a testament to his enormous contribution to the subject.

Building upon this, the UNESCO-funded International Geoscience Programme (IGCP) project no. 449 ('Global Correlation of Late Cenozoic Fluvial Deposits'), has included a Palaeolithic working group. During the course of the project (2000–2004) there were significant advances in Europe, with discoveries of very early fluvio-estuarine archaeological records in eastern England (Parfitt *et al.*, 2005) and of a fossiliferous tufa at the Acheulian type locality, St Acheul (River

Somme), northern France (Antoine and Limondin-Lozouet, 2004; see below). During this period the initial projects born out of the British Government's Aggregates Levy Sustainability Fund included new studies of Palaeolithic fluvial archives in southern Britain. This period has also coincided with the Leverhulme-funded AHOB (Ancient Human Occupation of Britain) project, which has initiated research on several fluvial sites and contributed to activities at many others, notably Lynford, Norfolk (Boismier *et al.*, 2003), and Whitemoor Haye, Staffordshire (Coates, 2002).

These initiatives, on top of an already healthy statutory developer-funding system for archaeological assessment and rescue ahead of civil engineering and building projects, has led, since 2000, to enhancement of knowledge of the British fluvial Palaeolithic record. High-profile examples of advances stemming from developer-funding include new descriptions of the key Thames locality at Purfleet (Schreve *et al.*, 2002), the discovery of artefacts in the celebrated fossiliferous deposits at Aveley (Bridgland *et al.*, 2003) and a new Clactonian locality that was discovered in association with River Thames tributary deposits at Southfleet Road, Swanscombe/Ebbsfleet (Wenban-Smith *et al.*, this issue, pp. 471–483). The main value of the IGCP 449 data bank, however, is in its usefulness for inter-regional and international comparison and correlation.

The last decade or so has seen a new understanding of Lower and Middle Palaeolithic technological sequences, largely established from fluvial records and predominantly from the reinterpretation of the British archive (Bridgland, 1998; White, 1998a,b; White and Schreve, 2000; White and Jacobi, 2002; White *et al.*, this issue, pp. 000–000). It has even been suggested that the artefact record from the Thames terraces can provide an indication of human population densities during the Pleistocene (Ashton and Lewis, 2002).

This paper will review the fluvial contribution since 2000, in the context of the IGCP 449 data resource, and particularly with a view to setting the British archive in the context of more widespread European evidence. The geographical scope of this synthesis is indicated in Fig. 1.

Fluvial sequences as contexts for the early archaeological record

The fact that a large proportion of the Pleistocene archaeological record comes from fluvial deposits is unsurprising, as rivers receive much coarse detritus from the landscapes they drain and much of this remains in their valleys in various bodies of sediment. Stone artefacts have thus found their way naturally into fluvial deposits (Wymer, 1999; Hosfield and Chambers, 2005), although some are included by virtue of human action, in that knapping locations on river beds and beaches have occasionally been preserved as primary-context industrial sites. Recognised by the presence of conjoinable material, such sites are arguably more important components of the record than the considerably more common instances where the artefacts are mere clasts within the former bedload of the river. The coincidence between the fluvial and archaeological record may result from other factors, such as the attractiveness of river valley locations for early human habitation and the opportunities for artefact discovery that resulted from gravel extraction, especially before mechanisation.

The most valuable fluvial archives are those in which dating evidence also occurs, providing a chronological framework for the archaeological record (cf. Wymer, 1999; Bridgland, 2000; Bridgland *et al.*, 2004a). Example sequences in which this principle has been well established, and which will be summarised in this paper, include those of the Thames (southern England), the Somme (northern France) and the Wipper, Ilm and Neckar (Germany). Once a well-dated archaeological sequence has been established from such records, it might be possible, within the same region, to use

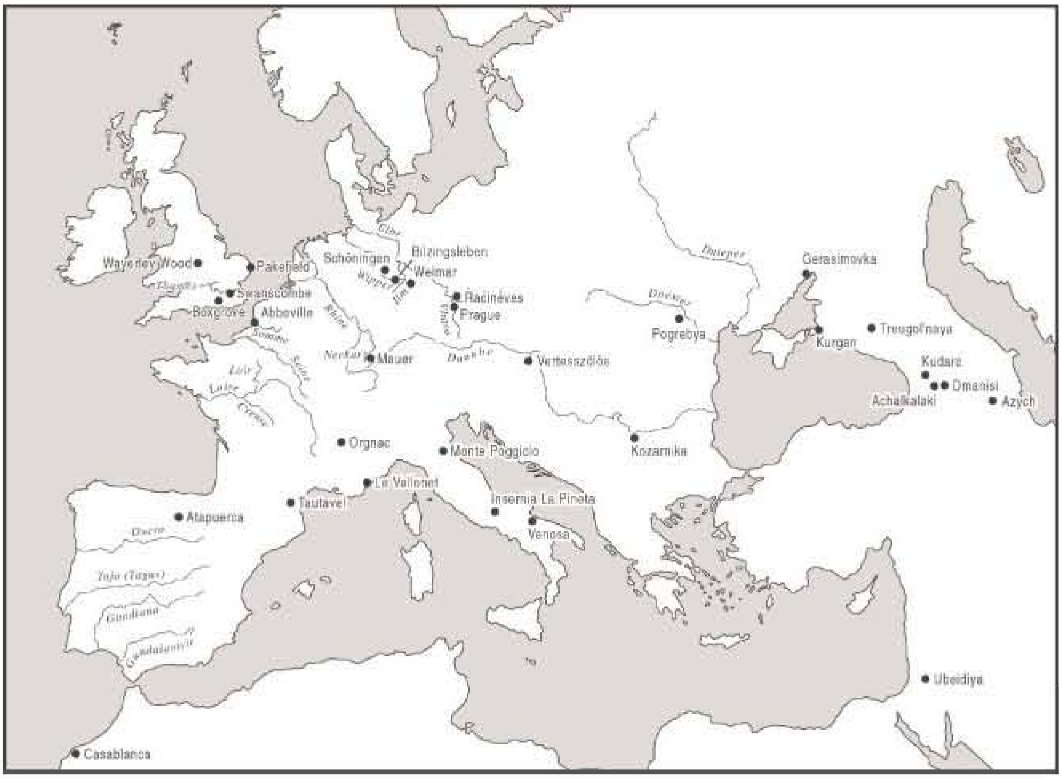

Figure 1 Location map, showing sites and areas discussed in the text, except for sites in Iberia, which are shown in Fig. 7

artefact assemblages as a means of dating other fluvial sequences in which alternative means of dating are scarce, provided that this is carried out with caution and awareness of potential confounding issues. An example system in which this has been attempted is the erstwhile Solent River of southern England (Bridgland, 1996, 2001; Westaway *et al.*, in press), long known as a rich source of artefacts but, on account of its acidic soils and groundwater, generally lacking the calcareous fossils that provide biostratigraphy and amino-acid geochronology, both of which have been important in elucidating the Thames record.

River Thames

There is a long and well-documented history of geological, palaeontological and archaeological research on the Thames sequence (for reviews see Wymer, 1968, 1999; Roe, 1981; Bridgland, 1994, 1998). The view that the archaeological record can be used as a dating tool has a long pedigree in the Thames; King and Oakley (1936) erected a correlation scheme using artefact assemblages as well as biostratigraphy, although this was set in the context of the oversimplified view of palaeoclimatic fluctuation that prevailed at that time. As well as their interpretation of the Quaternary record, the archaeological divisions applied by King and Oakley are now seen as outmoded, although their scheme, at least in part, was widely adhered to as late as the 1970s (Conway, 1970; cf. Evans, 1971; Wymer, 1974). Following this, and perhaps because the archaeological aspects of the King and Oakley scheme were seen to have been misleading, a view has prevailed during recent decades that artefact typology should not be used for dating (Wymer, 1968). The first hints that this might be overly pessimistic were made by Wymer (1988), after which Bridgland (1994) demonstrated that, in the context of a more complex late Middle Pleistocene climato-stratigraphy, the Palaeolithic record of the Thames showed clear patterns of probable chronological significance. His scheme for the post-Anglian Lower Thames, subsequently underpinned by mammalian biostratigraphy (Schreve, 2001; Bridgland and Schreve, 2004), is illustrated in Fig. 2, which also shows the stratigraphical locations of different archaeological assemblages.

Based partly on the Thames, Bridgland (2000) suggested several archaeological markers that might, when recognised within fluvial sequences, be useful as dating proxies. These were (1) the first appearance of artefacts, (2) the first appearance of Levallois technique and (3) the disappearance of fresh artefacts owing to depopulation before the last interglacial (prior to reappearance as Mousterian and Upper Palaeolithic). Other artefact occurrences of potential dating significance relate to two distinct types of handaxe: (1) twisted ovates, tentatively associated with MIS 11 (White, 1998b), and (2) *bout coupés*, which generally date from MIS 4/3 (White and Jacobi, 2002).

The earliest of these age indicators, the first appearance of artefacts, is poorly identified in the Thames. The Lower Thames record (Fig. 2) begins with the Anglian glaciation, before which the river flowed in a different valley further north (Gibbard, 1977, 1979; Bridgland, 1988, 1994) and by which time people had already arrived in Britain. In the Middle Thames there are artefacts in the Anglian Black Park gravels of the 'Caversham Channel' (Wymer, 1968; Bridgland, 1994) but none are recorded from the higher Winter Hill terrace (also Anglian) or from any older Thames deposit. This fact has become increasingly puzzling as the occupation of Britain has been pushed back into the early Middle Pleistocene by evidence from Boxgrove (Roberts and Parfitt, 1999), Waverley Wood (Shotton *et al.*, 1993) and, more recently, from Pakefield in East Anglia, in sediments associated with the Pre-Anglian Bytham River (Parfitt *et al.*, 2005). A possible explanation lies in the Anglian glaciation of the former Thames valley north of London, which not only diverted the river (Gibbard, 1977, 1979) but also, through the effects of glacio-isostasy, depressed the crust in the Middle Thames area. As a result, the contemporaneous Winter Hill gravel was built up to a considerable thickness, burying any early Middle Pleistocene terraces that might have existed there. After isostatic recovery, the Winter Hill terrace surface is some 22–25 m higher than it would have been without this effect (Maddy and Bridgland, 2000; Westaway *et al.*, 2002). Downstream in northeast Essex, where an early Middle Pleistocene Thames terrace staircase is preserved beyond the direct influence of the Anglian glaciation (Bridgland, 1988, 1994), there have been Palaeolithic discoveries at a number of localities, although the deposits yielding artefacts have typically been interpreted as reworked

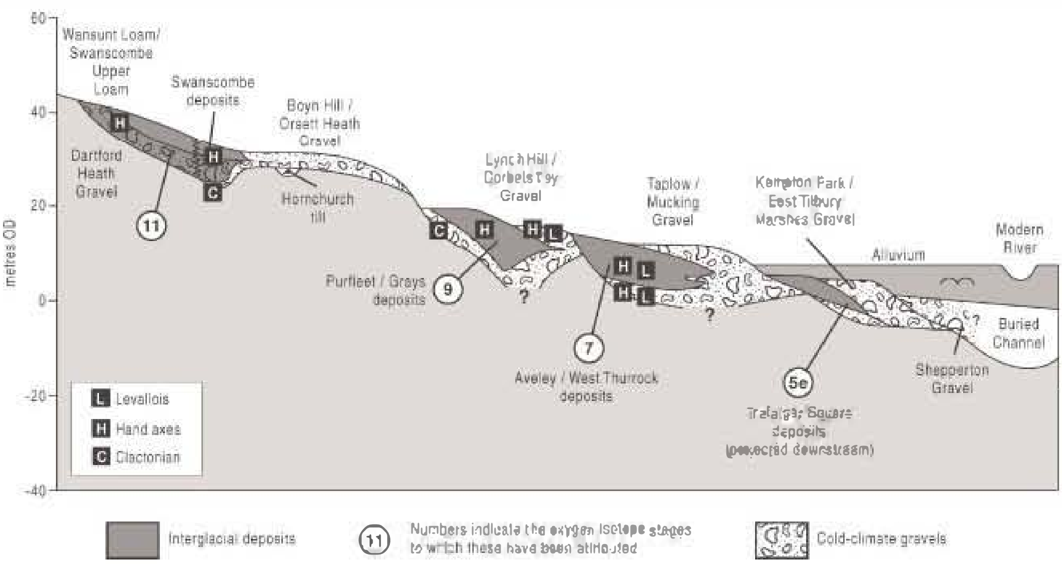

Figure 2 Idealised transverse section through the terraces of the Lower Thames, showing interbedded cold- and warm climate deposits and the stratigraphical positions of Palaeolithic industries (modified from Bridgland, 1994)

Thames gravels laid down in the late Middle Pleistocene by local streams (Thames tributaries) such as the Holland Brook (e.g. Dakings Pit, Weeley/Thorpe-le-Soken; Wymer, 1985: 262–233). Reappraisal of such occurrences may now be appropriate.

The timing of what is arguably the most important archaeological marker, the appearance of Levallois technique, has largely been established from the Thames. Artefacts showing the use of Levallois technique first appear within the Thames sequence towards the top of the Lynch Hill/Corbets Tey Formation, an observation based on the record from Purfleet in the Lower Thames (Wymer, 1968; Bridgland, 1994; Schreve *et al.*, 2002), although Wymer (1968, 1988) had noted Levallois occurrences at some Lynch Hill sites in the Middle Thames. Explanation of the appearance of Levallois is complicated by the occurrence in basal Lynch Hill deposits, both at Purfleet and Little Thurrock, of Clactonian assemblages (Bridgland, 1994; White and Schreve, 2000). Once thought to be of considerable chronological significance and earlier within the British sequence than the Acheulian (King and Oakley, 1936), then questioned as a separately definable industry (Ashton and McNabb, 1992; McNabb, 1996), the Clactonian is now regarded as of limited chronological value. Its appearance in basal Boyn Hill/Orsett Heath deposits as well as in the Lynch Hill Formation, in both cases followed by Acheulian occupations (Bridgland, 1994, 1998; White and Schreve, 2000), indicates separate Clactonian occurrences early in both MIS 11 and MIS 9 (Fig. 2). White and Schreve have related these to Britain's fluctuating climatic and island status, the Clactonian possibly representing an early interglacial dispersal of hunter-gatherers from an eastern province in which handaxe making was absent (see below). At Purfleet, in a sequence representing MIS 10, 9 and 8, three distinctive industries appear in superposition (Schreve *et al.*, 2002), with Clactonian below Acheulian within MIS 10–9, then Levallois appearing in the upper cold-climate gravel (Fig. 2). Whether the last-mentioned reflects the MIS 9–8 cooling transition or earlier, following the MIS 9c–9b boundary, remains a question for the future (cf. Westaway *et al.*, in press).

The Thames record was also key to White's (1998b) suggestion that assemblages rich in twisted ovate handaxes date from late in MIS 11. Collections with this characteristic are documented from Wansunt and Bowman's Lodge Pits, Dartford Heath, the Upper Loam at Barnfield Pit, Swanscombe, and the deposits at Rickson's Pit, Swanscombe, all within the Boyn Hill/Orsett Heath sequence and ascribed to MIS 11 (Fig. 2). The other two potential archaeological markers, however, are poorly represented in the Thames sequence. Both *bout coupé* handaxes and Upper Palaeolithic artefacts are known in the Lower Thames only from deep beneath the valley floor (or dredged from the river bed); this is unsurprising, since the Late Pleistocene fluvial contexts that would contain them are unrepresented at higher levels in the terrace staircase (Fig. 2).

River Somme

The Somme valley in northern France is another that has a long history of Palaeolithic research (e.g. de Mortillet, 1872; Commont, 1910; Breuil and Koslowski, 1931, 1932; Bourdier, 1969; Sommé and Tuffreau, 1978; Tuffreau *et al.*, 1982; Sommé *et al.*, 1984; Haeserts and Dupuis, 1986; Antoine, 1990, 1994; Antoine and Tuffreau, 1993; Tuffreau and Antoine, 1995; Antoine *et al.*, 2000). It is the location of two Palaeolithic type localities: Abbeville and St Acheul. The latter has given its name to the Acheulian, which accommodates all the Lower Palaeolithic handaxe industries. As such it now eclipses the former, the name 'Abbevillian' having been applied to what were once thought to be relatively primitive, early handaxes. Indeed, the early archaeological discoveries from the Abbeville area (Commont, 1910) are now considered less reliable than the well-dated younger *in situ* Acheulian assemblages (MIS 12–9) discovered during the last two decades (Antoine *et al.*, 2003a; see below, also Fig. 3).

The chronostratigraphical interpretation of the Somme terrace staircase was initially based on the recognition of a cyclic glacial–interglacial pattern within the fluvial sequences and the overlying loess-palaeosol deposits (Haeserts and Dupuis, 1986, Antoine, 1990, 1994; Antoine *et al.*, 2003a,b). It has been confirmed by amino-acid geochronology, based on mollusc shells from the fluvial sediments (Bates, 1994), and by site-specific supplementary data from biostratigraphy (Auguste, 1995), magnetostratigraphy and by ESR and U-series dating (Laurent *et al.*, 1994; Antoine *et al.*, 2000, 2003a,b, in press; Fig. 3).

Although numerous handaxe industries were found in the early 20th century within the 'old terraces' at Abbeville and Amiens, is difficult to determine the age of the earliest human occupation in the Somme basin. This has generally been ascribed to the Carpentier Quarry at Abbeville (Commont, 1910). However, excavation here in 1989, for ESR and palaeomagnetic sampling, failed to find artefacts, although mammalian remains were recovered (Antoine, 1990). At this quarry, the well-known *Marne Blanche* is represented by fine-grained temperate-stage deposits, overlying cold-stage fluvial gravels of the Renancourt terrace (alluvial formation VII). The temperate-stage sediments have yielded abundant mammalian evidence with clear pre-Elsterian characteristics, including *Stephanorhinus hundsheimensis* (Commont, 1910; Pontier, 1928; Tuffreau and Antoine, 1995). The *Marne Blanche* is dated to MIS 15 by one ESR date from quartz grains (600 ± 90 ka) and others (509 ± 110 and 589 ± 134 ka) from sand lenses in the underlying cold-stage gravels at Cagny-Rocade (Antoine *et al.*, 2003a).

The Saint Acheul type locality coincides with the Garenne Formation (MIS 12–11), located two bedrock steps below the level of Abbeville (Fig. 3). The intervening Fréville Formation (MIS 14–13) has also yielded abundant Acheulian artefacts, particularly at *Rue Marcelin Berthelot*, Saint-Acheul (Tuffreau and Antoine, 1995), where handaxes have been found in the cold-stage gravel. In the main Saint-Acheul terrace (Garenne Formation) there have been significant advances in knowledge during the life of IGCP 449, with the discovery of a fossiliferous tufa at the type locality, for which an ESR age of 403 ± 73 ka has been obtained (Antoine and Limondin-Lozouet, 2004). The molluscan fauna from this tufa is composed of 60 taxa, of which 23 are forest species (Antoine and Limondin-Lozouet, 2004). This assemblage points unequivocally to climatic optimum conditions. The presence of certain molluscs beyond their modern range, together with the extinct *Retinella* (*Lydrodiscus*) *skertchlyi*, indicates that the Saint-Acheul malacofauna (with similar tufa assemblages elsewhere) belongs to the *Lydrodiscus* biome, attributed to MIS 11 (Rousseau, 1987; Rousseau *et al.*, 1992; Preece *et al.*, 2000). Other geochronological control for the *Lyrodiscus* biome includes the U-series dating from Vernon, in the Seine (Lécolle *et al.*, 1990), and U-series and TL dates from Beeches Pit, West Stow, England (Preece *et al.*, 2000, and this issue, pp. 485–496). The comparable tufa in the Seine valley at St Pierre-les-Elbeuf, feared to have been quarried away, has been rediscovered recently.

The Garenne Formation is also represented by a major Palaeolithic site at Cagny-la-Garenne, which has yielded numerous Acheulian artefacts, as well as ESR dates of

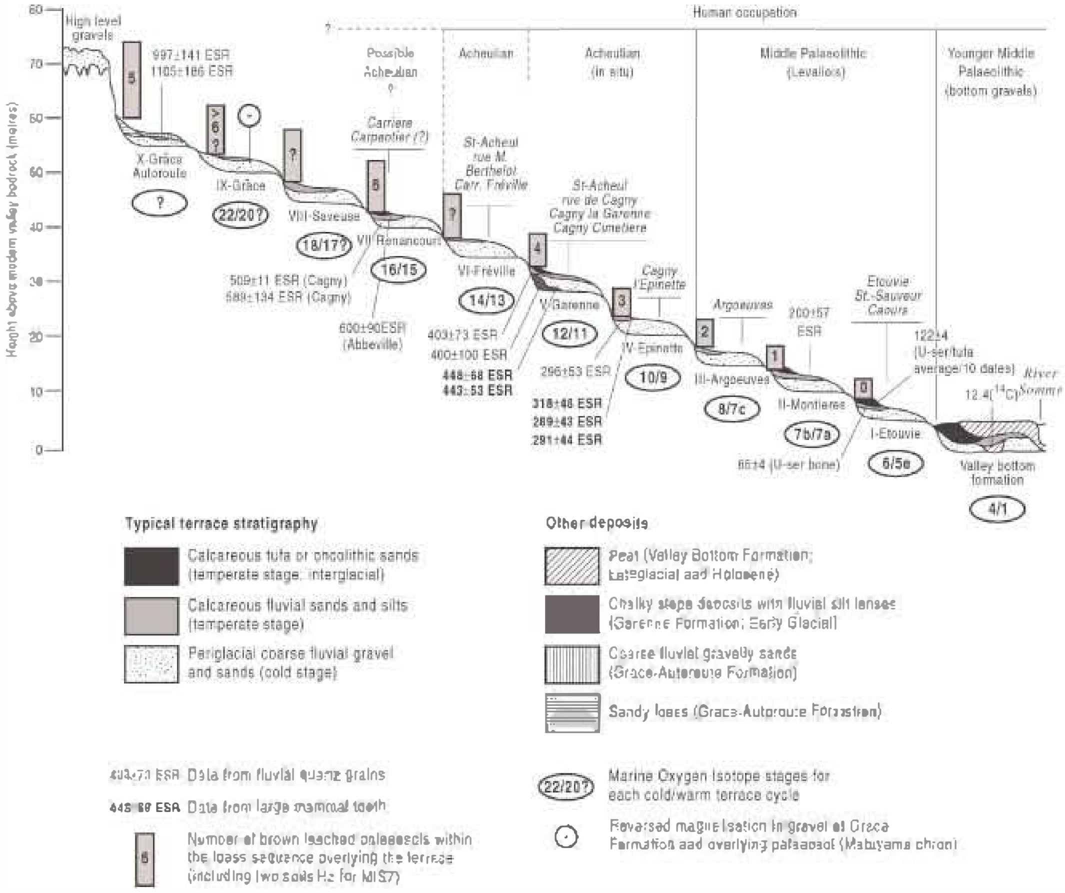

Figure 3 Idealised transverse section through the terraces of the River Somme, northern France, modified from Antoine *et al.* (2003a,b, in press). All numerical ages are in ka

400 ± 101 ka (Tuffreau and Antoine, 1995) and 448 ± 68 and 443 ± 53 ka (Antoine *et al.*, 2003a). Tuffreau and Antoine (1995) inferred that a small number of Levallois flakes and cores may be present in these deposits, but these may instead be by-products of handaxe manufacture. The assemblage discovered in the *Sables Roux* (*Atelier Commont*) overlying the Garenne Formation at Saint-Acheul is located within significantly younger sediments included within the slope deposits, clearly unrelated to the Garenne fluvial sequence. This assemblage, including numerous twisted handaxes and various tools of 'Middle Palaeolithic style', has been interpreted as the youngest Acheulian industry from the Somme (MIS 9?), representing a transitional facies between Acheulian and Middle Palaeolithic (Tuffreau, 1987).

The next terrace in the Somme staircase is formed by the Épinette Formation (Fig. 3), which was well exposed at its type locality, Cagny-l'Épinette. The aggradation of the fine calcareous silts of the Épinette Formation is allocated to MIS 9, using mammalian biostratigraphy and ESR dates from quartz grains and mammal teeth (296 ± 53ka, 291 ± 44 and 318 ± 48ka). The Épinette site represents the last *in situ* occurrence of typical Acheulian industry within the Somme valley staircase.

As was noted by Tuffreau (1982, 1995; cf. White and Ashton, 2003), the Argoeuves Formation, overlying the next bedrock step (terrace III), marks the first clear evidence of Levallois technique within the Somme system (Fig. 3). The lower terraces repeat the characteristic Somme pattern of temperate-stage deposits overlying cold-stage ones. As is indicated by the notation in Fig. 3, the younger terraces are overlain by progressively fewer loess and palaeosol layers, providing an indication of the number of climate cycles since the formation of each terrace. However, there is not an exact correspondence between these loess–palaeosol couplets and glacial–interglacial cycles during MIS 8 and 7, because the Montières terrace is thought to mark the later part of MIS 7 rather than a complete climate cycle (Fig. 3). According to the Somme data the impact of the cold stage within MIS 7 (MIS 7b?) was sufficient to produce an incision and a new gravel aggradation (Montières Formation). This interpretation is supported by an ESR date of 200 ± 57 ka for the temperate-stage deposits of this terrace, by the number of incisions (four) between the well-dated Garenne (MIS 12-11) and modern valley (MIS4-1) formations, and by the evidence of significant loess accumulation between the two soils of MIS 7 (Antoine, 1990, 1994; Fig. 3).

The youngest Somme terrace is the Étouvie formation, lying at 5–6 m above the maximum incision level in the valley (Fig. 3). This formation comprises periglacial gravels with many Levallois flakes, overlain by fluvial silts and locally by interglacial (Eemian) calcareous tufa. Indeed, the Eemian tufa at Caours, about 5 km from Abbeville on the left bank of the tributary Scardon stream, has been researched during the course of IGCP 449 and found to contain Middle Paleolithic artefacts, thus providing important evidence that humans reached northern France during the Last interglacial (Antoine *et al.*, in press). This last terrace is buried by a slope sequence dated from the Last Glacial period (Early Weichselian humic soils then loess in MIS 4–2). Later Middle Palaeolithic is also found as reworked artefacts in the gravels of the Valley Bottom formation.

In summary (Fig. 3), the oldest unequivocal human occupation in the Somme dates from within the Fréville Formation around MIS 14 and is Acheulian. An earlier occupation, coincident with the *Marne Blanche* (ca. MIS 15), is possible but needs further research. *In situ* Acheulian occupations are well known from modern excavations within the deposits of the Garenne and Épinette formations (MIS 12–9). Middle Palaeolithic industries (Levallois) appear at the transition between the end of the aggradation of the Épinette and the Argoeuves formations (MIS 9–8) and then develop in the following 'low terrace' alluvial formations (MIS 8–5e). Finally, youngest Middle Palaeolithic artefacts are found in the gravels of the modern valley-floor, deposited during the Last Glacial (MIS 4–3?).

Rivers Wipper and Ilm

The Wipper, a tributary of the Saale–Elbe system, is a minor river, but one that has an exceptional Quaternary record, thanks in no small part to the calcareous Muschelkalk bedrock in its catchment. The resultant calcareous groundwater has caused subaerial travertines to form on the Wipper valley floor during successive Pleistocene interglacials, as has been documented from the remarkably complete sequence in a single meander core at Bilzingsleben (Mania, 1995; Mania and Mania, 2003; Bridgland *et al.*, 2004b; Fig. 4). The same is true of the River Ilm, another Saale–Elbe tributary, the travertines from its valley having been quarried for building stone over a lengthy period. Occurring at several levels within the Ilm sequence (Fig. 5), these include the well-known Ehringsdorf travertines at Weimar, within which hominin fossils and living sites are recorded, as well as an assemblage of predominantly (but not exclusively) small Palaeolithic artefacts, termed 'Lower Palaeolithic Microlithic Tradition' (*LPMT*; e.g. Burdukiewicz and Ronen, 2003), of a general type that is characteristically found in central Europe (Valoch, 1984, 2003; Moncel, 2003). At Taubach is another travertine, again overlying an Ilm terrace, that is widely attributed to the Eemian (Bridgland *et al.*, 2004b). It has yielded another *LPMT* assemblage, providing a clear indication that human populations were present here during the Last Interglacial, despite not reaching Britain (see also above: evidence from Caours). Ehringsdorf was long regarded as Eemian and therefore the same age as Taubach (Kahlke, 1974, 1975), the archaeological similarities of the two travertines providing support for this view (Moncel, 2003). Mammalian biostratigraphical evidence, however, suggests that the Ehringsdorf travertines date from MIS 7 (Schreve and Bridgland, 2002; Bridgland *et al.*, 2004b), a view supported by U-series dating (Blackwell and Schwarcz, 1986; Mallik *et al.*, 2000; Fig. 5).

Figure 4 shows interglacial travertines at six separate levels within the Wipper staircase. Although the lowest three travertine levels have been established only in temporary sections, and have yet to be investigated for faunal content, there are several dating constraints for this sequence. At around 10 m higher than the highest travertine, in a different section of valley, outwash from the Elster I glaciation has been recorded, incised below till attributed to the same glacation (Fig. 4). The Elster I was correlated with MIS 14 by Šibrava (1986). This might allow the oldest Wipper travertine, at the Bilzingsleben I level (Fig. 5), ca. 35 m above the river, to be attributed to MIS 13 (cf. Bridgland *et al.*, 2004b). However, a gravel at a similar level, interpreted as pre-dating this travertine (although not present in the Bilzingsleben meander core—see Fig. 4) was stated by Mania (1995: 86) to be 'generally regarded as of late Elsterian origin'. If this is taken to mean Elster II (= MIS 12 according to Šibrava, 1986), the oldest Wipper travertine must date from MIS 11 (Holsteinian), as suggested by Schreve and Bridgland (2002). Both the travertine at this highest interglacial level and fluvial sediments beneath it contain mammalian and molluscan fossils, the assemblages including *Stephanorhinus kirchbergensis*, *Palaeoloxodon antiquus* and *Theodoxus serratiliniformis*. The fluvial deposits also contain flint flakes (Mania, 1995).

The best known of the travertines is that at the Bilzingsleben II level, ca. 30 m above the Wipper (Fig. 4), within which the archaeological site has been excavated. Thanks to its preservation in travertine, the archaeological assemblage, summarised by Mania and Mania (2003), includes bone, tusk and (pseudomorphic) wooden artefacts, as well as flint and quartzite artefacts. The lithics are predominantly small (another example of *LPMT*), made from glacially transported clasts, but larger pieces are present. Even at the larger extreme, handaxes are missing, although some tools are bifacially worked (cf. Mania and Mania, 2003; Brühl, 2003). Some core-preparation has been recognised (Mania and Mania, 2003), but the site lacks Levallois technique. The travertine and interbedded fluvial deposits overlie the gravel of what Mania (1995) called the 'glacial 27 m terrace' (Fig. 4). The bivalve *Corbicula fluminalis* occurs only in the interglacial fluvial sediments although *T. serratiliniformis*, present in both Bilzingsleben I and II, is occasionally found in the archaeological level within the travertine (Mania, 1995). In Britain this gastropod has been

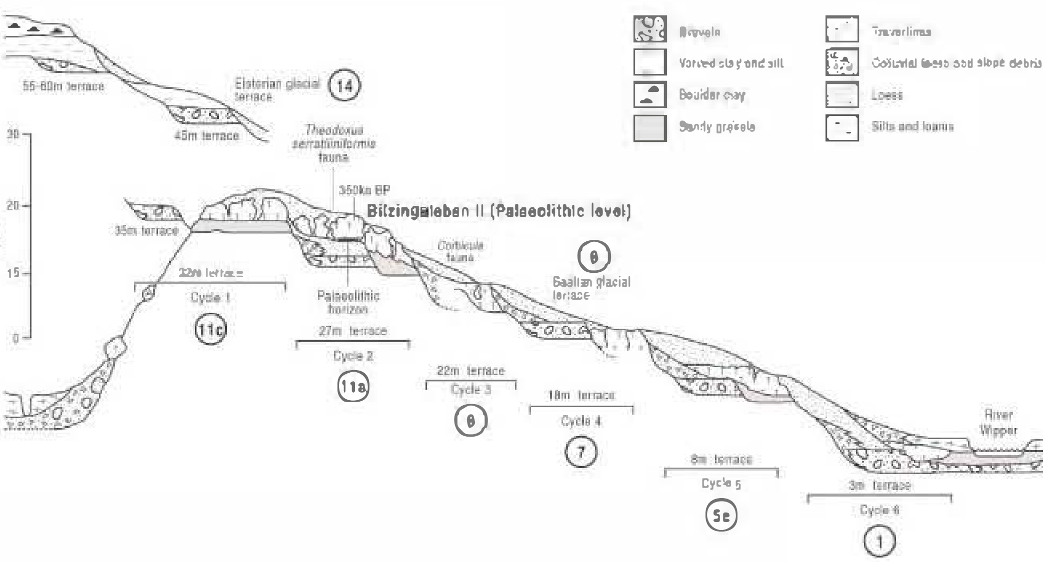

Figure 4 Transect through the terraces of the River Wipper at Bilzingsleben, Thuringia, Germany. Modified from Mania (1995). For location see Fig. 1

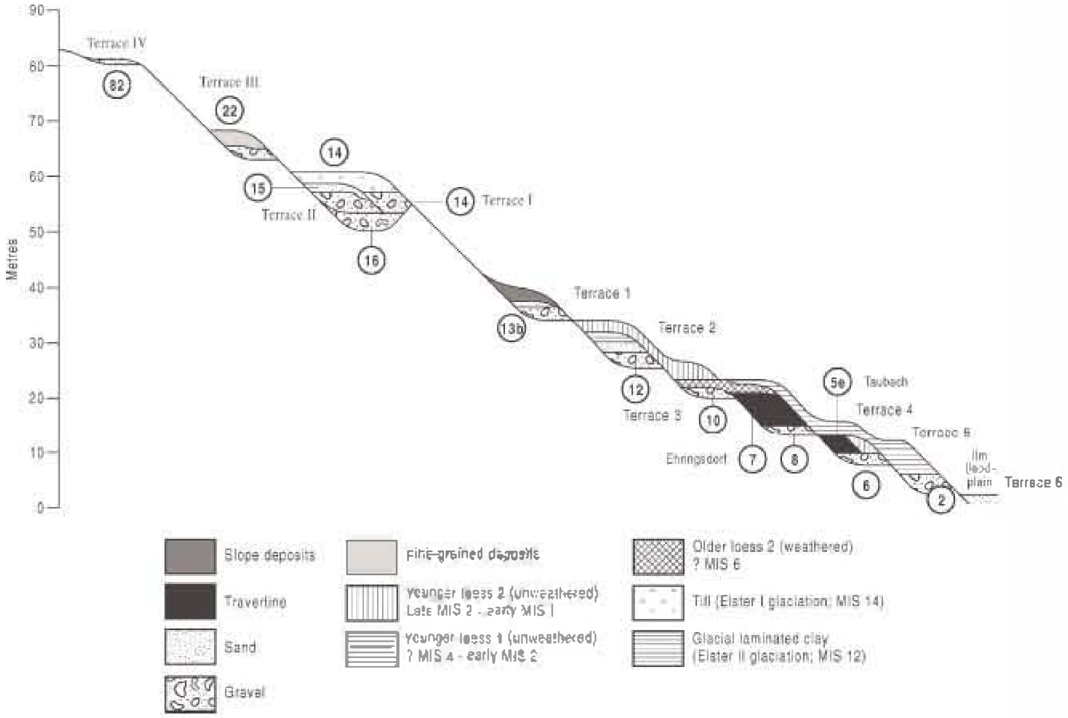

Figure 5 Idealised transect through the terraces of the River Ilm around Weimar, Germany. Modified from Bridgland *et al.* (2004b). For location see Fig. 1. The definitive description of the Ilm sequence is that by Soergel (1924, 1926), who recognised a staircase of 10 aggradational terraces. Soergel placed the Ehringsdorf interglacial between the deposition of the Ilm Terrace 4 and Terrace 5 gravels. The two pre Weichselian North German glaciations known to him, now classified (cf. Šibrava, 1986) as Elster I (MIS 14?) and Elster II (MIS 12), provide further dating constraints (Bridgland *et al.*, 2004b). During the Saalian glaciation(s), ice did not reach the Weimar area (Unger and Kahlke, 1995)

regarded as an indicator of the Hoxnian (MIS 11) interglacial (Preece, 1995). The rich mammalian fauna from this travertine has elements characteristic of MIS 11, notably *Trogontherium cuvieri* and *Ursus deningeri-spelaeus* (Schreve and Bridgland, 2002; Bridgland *et al.*, 2004b). It seems likely that the Bilzingsleben I and II interglacials both date from MIS 11, perhaps representing the two warm sub-stages 11c and 11a (cf. Schreve and Bridgland, 2002), although this is very much dependent on the interpretation of the local Elsterian glacial deposits (cf. Bridgland *et al.*, 2004b).

The Bilzingsleben III travertine, ca. 25 m above the river (Fig. 4), has also been studied by Mania (1995), although only its molluscan fauna has been reported thus far. This is an assemblage characteristic of the Middle Pleistocene, with components suggestive of a mixed oak forest. Mania (1995) suggested correlation of Bilzingsleben III with the Schöningen Interglacial at the site of that name (see below; Fig. 1) and with the Dömnitz interglacial (=MIS 9 according to Šibrava, 1986). As Fig. 4 reveals, there are three lower travertines, at ca. 18 and ca. 12 m above the river and near river level. If the last is regarded as Holocene it seems reasonable to ascribe the other two to MIS 7 and MIS 5 in descending order, perhaps representing the warmest (woodland) substages of each (7e and 5e).

River Neckar

Situated ca. 250 km southwest of the Wipper and Ilm, and also on Muschelkalk, the Neckar system again combines a well-developed terrace record with interbedded fossiliferous (interglacial) travertines and hominin fossil occurrences. Its terraces can also be dated, like those of the Somme, with reference to soils in loess/colluvial overburden (Bibus and Wesler, 1995; Bosinski, 1996; Fig. 6). One of several tie-points in the Neckar sequence is the type locality of *Homo heidelbergensis* at Mauer (Schoetensack, 1908). The sand pit here yielded no unequivocal artefacts, although it was a rich source of mammalian fossils, including the human mandible. It is situated in a 16 km long meander loop that was abandoned by the Neckar during the early Middle Pleistocene. The mammalian fauna is of early Middle Pleistocene affinities, with, for example, *Arvicola cantiana, Ursus deningeri, Stephanorhinus hundsheimensis* and *Homotherium* sp., and resembles immediately pre-Anglian faunas in Britain such as that from Westbury-sub-Mendip, implying a late Cromerian Complex age. 'Cromerian shells' recorded in the 23-m terrace, which is below the Mauer (33-m terrace) level, suggest that the Mauer deposits do not represent the most recent part of the Cromerian Complex, however. If *A. cantiana* is characteristic of the last two Cromerian Complex interglacials (van Kolfschoten and Turner, 1996; Preece and Parfitt, 2000), then it would seem that Mauer represents the earlier of these, perhaps the older of the two substages of MIS 13 (cf. Schreve and Bridgland, 2002; Tyrácek *et al.*, 2004).

The second hominin locality in the Neckar system is Steinheim-an-der-Murr; the human skulls from Steinheim and Swanscombe, frequently compared, have both been considered Holsteinian (MIS 11; cf. Schreve and Bridgland, 2002). Their accompanying vertebrate faunas are, indeed, highly similar, with *S. kirchbergensis, S. hemitoechus* and *U. spelaeus.* Comparison of the stratigraphical position of the Steinheim deposits within the Neckar/Murr terrace sequence with that of the Swanscombe sediments in the Thames strengthens the suggested correlation; there are three terraces below the Holsteinian level and above the floodplain in both (Figs. 2 and 6).

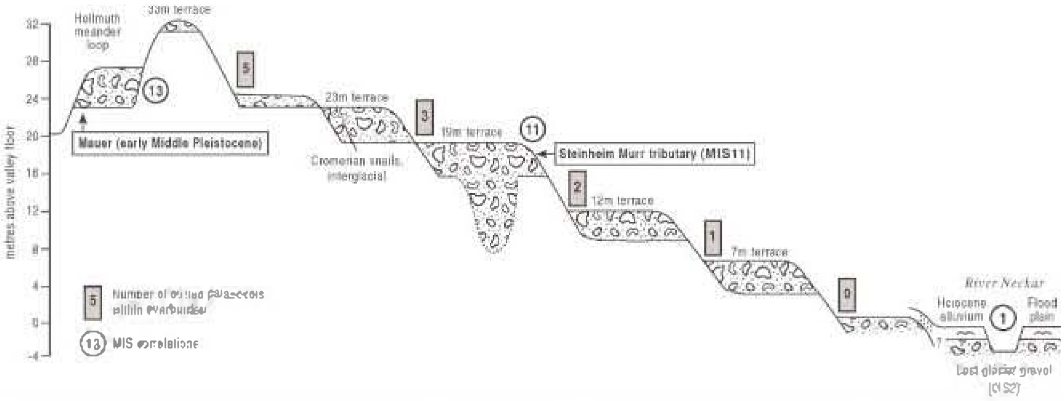

Figure 6 Idealised transect through the terraces of the River Neckar in the Heidelburg and Stuttgart areas of Germany, showing the stratigraphical positions of the Mauer and Steinheim hominin localities. Modified from Schreve and Bridgland (2002) and by them from Bibus and Wesler (1995). For location see Fig. 1

Wider comparisons in Europe

Given that humans are believed to originate in Africa, it is perhaps to be expected that the earliest European artefacts will be found in the south. The oldest material of all, dating from the early part of the Early Pleistocene, is found in southeast Europe, presumably reflecting the initial migration of early humans from Africa into Europe via the Levant, tracking structurally familiar biomes (e.g. Dennell, 2004). Key sites of great antiquity (Fig. 1) include Dmanisi in Georgia (ca. 1.8 Ma) and Ubeidiya in Israel (1.4 Ma; Bar-Yosef, 1998). The earliest unequivocal evidence of a human presence in the central and western Mediterranean regions indeed appears somewhat later in the record. Lower Palaeolithic material is well known from the terrace deposits of many Iberian Rivers (e.g. Santonja and Villa, 1990; Raposo and Santonja, 1995), the earliest evidence dating from ca. 1.1 Ma (see below). In Italy the earliest evidence for occupation is generally considered to be at Monte Poggiolo (Fig. 1), where a rich assemblage of artefacts made from small flint pebbles has been recovered from deltaic gravels associated with fossiliferous sands that are also dated (ESR and palaeomagnetism) to ca. 1 Ma (e.g. Antoniazzi *et al.*, 1993; Mussi, 1995). In southern and central France, *in situ* pebble-culture artefacts have been claimed in high fluvial terraces of a number of rivers, such as Terrace I (52 m above river level) of the Loir (tributary of the Loire; Despriée *et al.*, 2005; Voinchet *et al.*, 2005). Although not yet dated, nor independently verified (cf. Roebroeks and van Kolfschoten, 1995) the stratigraphical position of this site relative to younger, dated, terraces suggests a probable age of ca. 1 Ma. One example that has been dated is the Pont-de-Lavaud pebble-culture site, situated in terrace D of the river Creuse, another Loire tributary (Despriée *et al.*, 2004, 2005; Voinchet *et al.*, 2005). There are 10 ESR dates from this terrace (e.g., Despriée *et al.*, 2004), ranging from 905 ± 100 ka to 1187 ± 200 ka; the weighted mean is 1034 ± 57 ka (± 2σ).

There is a pattern apparent in the distribution of Lower Palaeolithic artefact assemblages in Europe: handaxe (Acheulian) signatures are normal in the south and west but generally absent in the north and east. In the latter area non-handaxe assemblages are found, some with larger artefacts and including similar technology to the British Clactonian (see above); in many, however, the dominant characteristic is the small size of artefacts, perhaps indicating scarce or poor-quality raw material. The interdigitation in Britain of Clactonian and Acheulian assemblages (Fig. 2) has, as noted above, been attributed to immigration of peoples with different lithic traditions from different parts of Europe (White and Schreve, 2000). Examples of the eastern non-handaxe, dominantly diminutive industries (*LPMT*) have already been encountered above, in the Ilm valley, where they occur at Ehringsdorf and Taubach. At nearby Bilzingsleben the lithics are very similar, although larger tools made from bone and quartzite are also found (Brühl, 2003), a fact that might lend support to the notion that small stone tools were a response to poor raw material resources.

The earliest claimed evidence of handaxe-making in southern France is from the 'Sol P' stratigraphic level at Caune de l'Arago cave, Tautavel, in the eastern Pyrenees mountains, thought by some to date from MIS 15–14 (Barsky and de Lumley, 2005; Fig. 1). This level stratigraphically overlies speleothem for which a U-series date of ca. 600 ka has been reported (de Lumley *et al.*, 1984). Similar timings are evident in rivers in central France. For instance, terrace F of the Loir, base 22 m above river level, is the oldest to have yielded any handaxes and has ESR dates of 482 ± 77 and 491 ± 75 ka (Despriée *et al.*, 2005). From the sequence of heights and dates of other terraces in the Loir staircase, this fluvial gravel probably aggraded in MIS 14.

The earliest evidence of Levallois in southern France dates from MIS 9, for example at Orgnac 3 in the Ardèche region, where it is dated by U-series and ESR to 309 ± 34 ka (Moigne and Moncel, 2005). The appearance of Levallois is thought to occur around 300 ka in many river systems in central France, on the basis of numerous ESR dates (Voinchet *et al.*, 2005), although resolution to oxygen isotope stage is limited by the small number of terraces in many of these sequences. For instance, in the Loir, terrace B (base 6 m above river level) consists of two superimposed gravels separated by sand, the upper gravel with Levallois and the lower gravel without, the sand being ESR dated to 241 ± 42 ka (Despriée *et al.*, 2005).

Iberia

The Iberian Peninsula (Fig. 7) offers an alternative migration route from Africa to Europe, via the Strait of Gibraltar (Roebroeks, 2001; Straus, 2001). Lower Palaeolithic artefacts are frequently found *in situ* in fluvial contexts here, particularly in the rivers draining to the Atlantic (e.g. in the terraces of the Duero, Tagus, Guadiana and Guadalquivir), although in other areas (the Ebro and the rivers draining to the central/southern Mediterranean coastline) no record has been found. Age

Figure 7 Location map for the sites in Iberia that are mentioned in the text. Solid lines denote major rivers; dashed lines denote tributaries

frameworks have been derived mainly from morphostratigraphical correlation of the best-dated fluvial sequences.

The earliest evidence of human occupation includes the presence of non-handaxe lithic industries in bed 3 at Fuente Nueva, in the upper part of the stacked fluvial/lacustrine sequence of the Guadix-Baza basin and associated with Lower Pleistocene faunas including *Mammuthus meridionalis* and species of *Allophaiomys* (Martínez-Navarro *et al.*, 1997). The bed, characterised by reversed polarity (Matuyama chron), has been claimed to slightly pre-date the Jaramillo subchron—ca. 1.1 Ma (Martinez-Navarro *et al.*, 2005), although the dating and correlation of the stratigraphy within this basin may need reviewing in the light of findings by Gilbert *et al.* (2006). Non-handaxe assemblages are also present in the Atapuerca karstic system (Carbonell *et al.*, 1995, 2001) in levels just below the Matuyama–Brunhes reversal (Parés and Pérez-González, 1995, 1999). The widespread presence of Early Pleistocene hominins is also suggested by similar artefacts in river terraces: e.g. the 70–75 m terrace of the Valderaduey (Santonja and Pérez-González, 2000–2001), the 80-and 60-m terraces of the Pisuerga, the 100- and 62-m terraces of the Tormes (Santonja and Pérez-González, 1984) and the ca. 125-m to ca. 60-m terraces of the Tagus (Pinilla *et al.*, 1995; Santonja and Pérez-González, 2000–2001; terraces T8 to T12 in Fig. 8a). These Tagus terraces pre-date the Matuyama-Brunhes boundary, which occurs near Toledo in the ca. 60 m terrace (Pinilla *et al.*, 1995; Terrace T13 in Fig. 8(a). As Fig. 8(a) indicates, evidence of human occupation is reported from other terraces of the Tagus system that are much older than the Matuyama–Brunhes reversal. An example is the La Mesa site (e.g. Raposo and Santonja, 1995) in the ca. 125 m terrace of the Alagón tributary (possibly equivalent to terrace T8 of the upper Tagus; Fig. 8(a)). However, this interpretation seems to be based on a single potential artefact (e.g. Santonja and Pérez-González, 2000–2001). There are other possible artefacts, classed as 'materiales de dificile interpretación' (e.g. Santonja and Pérez-González, 2000–2001), from higher terraces of the Tagus (T5–T7 in Fig. 8(a)).

The Acheulian is more widely distributed, both in caves (e.g. Atapuerca; Pérez-González *et al.*, 1999) and in fluvial terraces. In the highest stratigraphical levels that contain *Mimomys savini* in the Atapuerca system, handaxes appear for the first time (Raposo and Santonja, 1995), presumably marking MIS 15. The handaxe makers may well have crossed the Gibraltar Strait from Morocco, where the earliest Acheulian assemblages around Casablanca (Fig. 1) appear from magnetostratigraphy to date from the latest part of the Matuyama chron (ca. 850 ka, or MIS 21: Raynal and Texier, 1989; Raynal *et al.*, 1995, 2002). Torralba and Ambrona are two important Iberian fluvial/lacustrine sites with Acheulian, located on the Bordecorex-Masegar (i.e. Duero-Ebro) interfluve (Fig. 7). Torralba is between the 35-m and 22-m terraces of the Masegar, whereas Ambrona is ca. 39–40m above this river (Pérez-González *et al.*, 1997). Correlation with the travertines capping the upper Henares terraces, which are well-dated using the U-series method (Benito *et al.*, 1998), suggests ages of MIS 12–8 for Torralba and pre-MIS 12 for Ambrona, consistent with the mammalian biostratigraphy (Soto *et al.*, 2001). In the Tagus catchment, the oldest Acheulian deposit is at San Bartolomé de Las Abiertas in the 60-m terrace of the Sangrera (a left-bank tributary joining the Tagus ca. 100 km downstream of Toledo); this terrace is considered equivalent to Tagus terrace T13 (Santonja and Pérez-González, 2000–2001; Fig. 8(a)) in which the Matuyama–Brunhes boundary has been reported (Pinilla *et al.*, 1995). The youngest Tagus terrace with Acheulian (T19 in Fig. 8(a)) is no older than MIS 6, by correlation with the upper

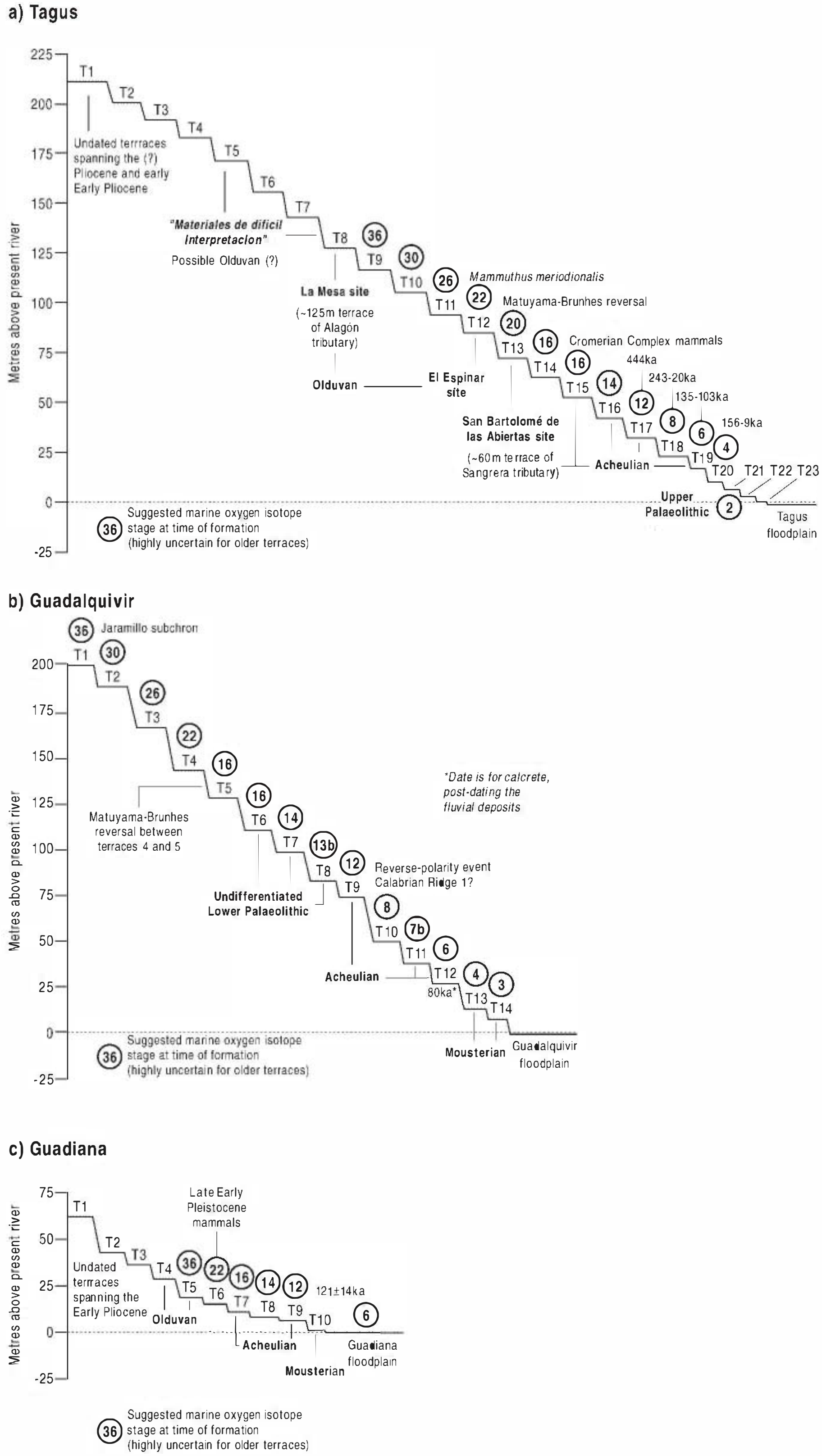

Figure 8 Schematic composite transverse profiles across the terrace staircases of major rivers in Iberia. (a) The River Tagus and its tributaries upstream of Toledo and in the vicinity of Madrid (the Henares, Jarama and Manzanares); after Pérez-González (1994), Santonja and Pérez-González (1997), Benito *et al*. (1998), Silva *et al*. (1999) and Santonja and Pérez-González (2000–2001). Incision by the Tagus is thought to have begun in the Late Pliocene (Middle Villafranchian, biozone MN17; Pérez-González and Gallardo, 1987). (b) The Middle Guadalquivir between Cordoba and Sevilla, including data from Bujalance, Carmona and Campana; from Díaz del Olmo *et al*. (1993) and Baena and Díaz del Olmo (1994). Along much of the Guadalquivir, incision began shortly after the Olduvai subchron (Baena and Díaz del Olmo, 1997). However, in the Guadix-Baza (Orce) Basin, now the uppermost part of the Guadalquivir catchment, stacked fluvial and lacustrine deposition continued until around the Early–Middle Pleistocene boundary (e.g. Martínez-Navarro *et al*., 1997). (c) The Guadiana (where much less incision has occurred), based on sites in the upper Guadiana: Guadiana (near Ciudad Real) and Záncara (near Alcázar de San Juan). From Portero (1988), Mazo *et al*. (1990) and Pérez-González (1994). The start of incision postdates the end of lacustrine deposition at the Valverde de Calatrava II mammal site, dated biostratigraphically to ca. 1.9–1.5 Ma (Mazo, 1999). Some inconsistencies exist between the cited references, indicating that further work is needed and that the terrace schemes illustrated should not be considered definitive. For locations see Fig. 7

Henares (Benito *et al.*, 1998). In the Guadalquivir, the earliest evidence of Acheulian postdates the Matuyama-Brunhes boundary (Díaz del Olmo *et al.*, 1989, 1993; Baena and Díaz del Olmo, 1994; Fig. 8(b)).

Middle Palaeolithic (Levallois or Mousterian) sites are mainly in caves, such as Atapuerca, where Levallois first appears in levels (TD11 in *Gran Dolina*) that are dated by ESR and U-series to 337 ± 29 ka (Falguéres *et al.*, 1999), or on the surfaces of river terraces. The few records of Mousterian from fluvial contexts include terraces T13 (13–14 m) and T14 (6–8 m) of the Guadalquivir, which postdate calcrete, capping terrace T12 (Fig. 8(b)), that has a U-series age of ca. 80 ka (Díaz del Olmo *et al.*, 1989, 1993; Baena and Díaz del Olmo, 1994). In the Guadiana, Mousterian occurs in the 1–2 m terrace (Fig. 8(c)), TL-dated to 121 ± 14 ka by Rendell *et al.* (1994); it appears to have continued until MIS 3 (Villaverde *et al.*, 1998).

Central Europe

The important Pleistocene fluvio-lacustrine sequence exposed in an open-cast lignite mine at Schöningen (Fig. 9), already mentioned, was deposited in a subsiding basin resultant from salt diapirism (Fig. 9). There are contrasting interpretations of the chronostratigraphy, one attributing the main archaeological layers, representing the Reinsdorf interglacial (Schöningen II), to MIS 9 and the Schöningen Interglacial (Schöningen III) to MIS 7 (Urban, 1995; Urban *et al.*, 1995). In contrast, Mania's (1995) correlation of these with Bilzingsleben II and III implies that he attributes them to MIS 11 and 9, respectively, an interpretation that is favoured by the occurrence of *Trogontherium cuvieri* in the Bilzingsleben II and Schöningen II deposits and of *Azolla filliculodes* in Schöningen III (Bridgland *et al.*, 1997; Schreve and Bridgland, 2002; Fig. 9). Artefacts also occur in the Schöningen I deposits, in the form of small flakes and flake-tools, in the company of burnt flints from which TL ages of >400 ka have been obtained (Thieme, 2003). The archaeology from the Reinsdorf interglacial (Schöningen II) includes wooden spears as well as 'cleft hafts' for supposed hafting of stone points. Once again the lithics are dominantly small (*LPMT*) and lack both handaxes and Levallois.

IGCP 449 participants have collected data from further east than these German sites, with valuable fluvial records being reported from Bulgaria, the Czech Republic, Hungary, Moldova and Ukraine, some with Lower Palaeolithic contents, from which a selection will be reviewed.

Racineves, River Vltava, Czech Republic

Building on earlier versions (Záruba, 1942; Balatka and Sládek, 1962; Šibrava, 1972; Záruba *et al.*, 1977; Tyrácek, 2001), a reappraisal by Tyrácek *et al.* (2004) recognised 18 Vltava terraces formed since the end of the Early Pleistocene (Fig. 10). A highlight is the site at Racinéves (Straškov 2 terrace), which has yielded interglacial mammalian and molluscan assemblages, important in the age calibration of the Vltava sequence (Tyrácek *et al.*, 2004), and the only unequivocal Palaeolithic assemblage within that sequence. Previously thought to be of late Cromerian Complex age (e.g. Tyrácek *et al.*, 2001), the Racineves interglacial was correlated by Tyräcek *et al.* (2004) with MIS 11 (Holsteinian). The archaeological material forms

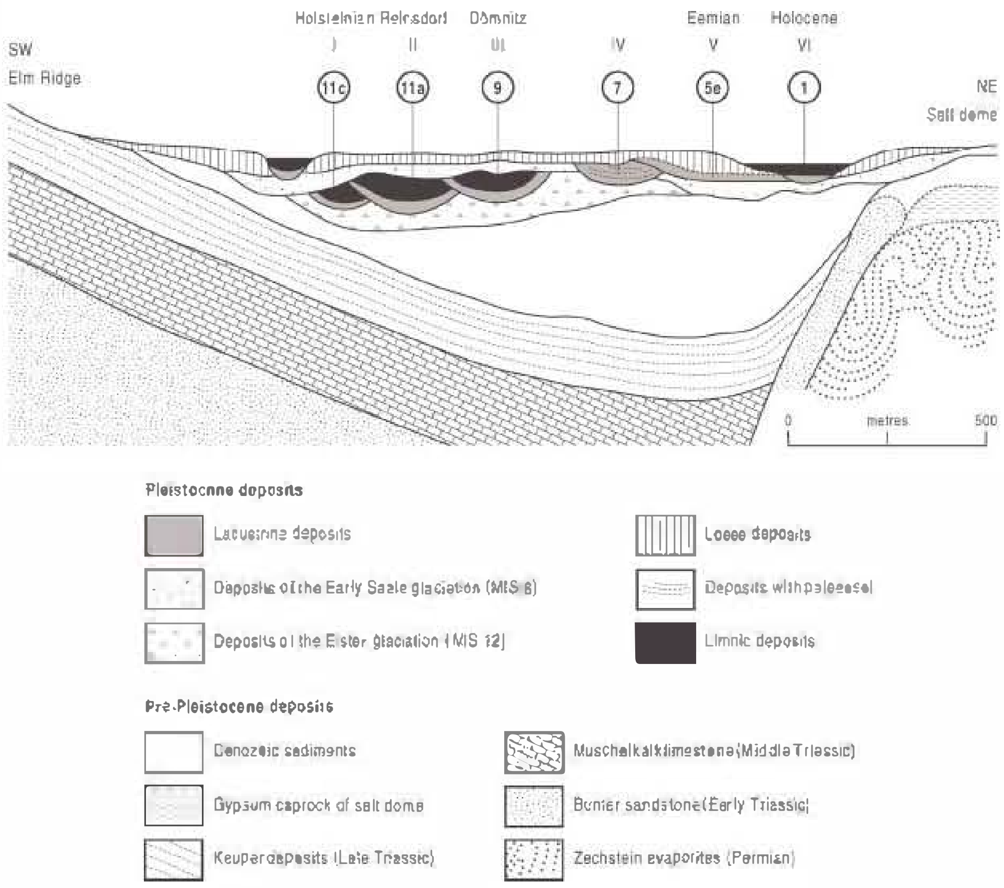

Figure 9 Sequence of Quaternary sediments exposed in the southern panel of the open cast lignite mine at Schöningen, central Germany. The Palaeolithic assemblages are from the Schöningen I and II deposits (MIS 11). Modified from Fig. 1 of Thieme (2003). For location see Fig. 1

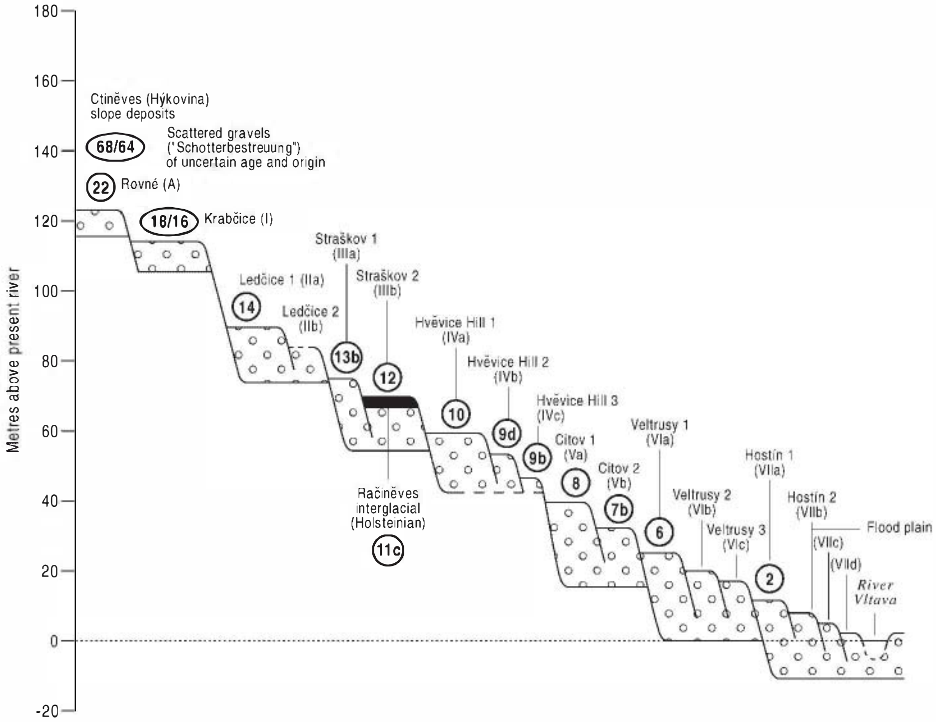

Figure 10 Idealised transverse section through the terraces of the River Vltava at Melník (ca. 25 km north of Prague), Czech Republic, showing the stratigraphical position of the Racineves archaeological horizon. Modified from Tyrácek *et al.* (2004). For location see Fig. 1

another of the central European *LPMT* assemblages, comprising cores, notches, knives, scrapers, wedges and hammerstones, all small and almost all made of Proterozoic lydite; some are in fresh condition, indicating a primary or near-primary context (Tyrácek *et al.*, 2001; Fridrich and Sýkorová, 2003). Cut-marks on some of the mammal bones provide further evidence of human occupation and activity. The small size and non-Levallois characteristics of the artefacts have led to comparisons with the assemblages from other Middle Pleistocene localities, such as Vértesszölös, in the Danube valley in northwest Hungary (see below), and Bilzingsleben II (see above). Vértesszölös is undoubtedly older than the other two sites, since it has yielded species characteristic of the late Cromerian Complex (*contra* Moncel, 2003; see below). The Racineves artefacts are also likened to the later, but similar, *LPMT* assemblages from the Ilm sequence (Burdukiewicz and Ronen, 2003; see above). Nevertheless, it demonstrates that humans were active in central Europe by ca. 0.4 Ma (see also Vértesszölös, below).

Vértesszölös, River Tata, Hungary

The fossil and Palaeolithic assemblages from Vértesszölös are from travertine capping Terrace V of the Tata, a tributary of the Danube (e.g. Kretzoi and Vertes, 1965; Kretzoi and Dobosi, 1990; Fig. 11). Most of Hungary lies within the Pannonian Basin, a major Late Cenozoic subsiding depocentre in which up to 2000 m of sediment has accumulated since the earliest Pliocene, ca. 600 m of it during the Pleistocene (e.g. Rónai, 1985; Gabris and Nador, in press). In contrast, Vértesszölös is in northwest Hungary, which is uplifting, leading to terrace formation by the Danube and Tata (Fig. 11).

In addition to chert, quartzite and bone artefacts, the Vértesszölös travertine has yielded human remains and abundant mammalian and molluscan fossils. It has yielded one of the many *LPMT* assemblages from central and eastern Europe (Moncel, 2003; above). Most of the 8890 artefacts are flakes and modified flakes, although a few have been interpreted (e.g. Dobosi, 1990) as diminutive handaxes or 'proto-handaxes'.

Like Racineves, the chronology of this key site has proved problematical. Dobosi (2003) attributed the travertine to the 'intra-Mindel' interglacial (MIS 13), between the Mindel I (? MIS 14) and the Mindel II (MIS 12) cold stages (cf. Šibrava, 1986), whereas Moncel (2003) suggested that it dates from MIS 9, on the basis of numerical ages (e.g. an ESR date of 333 $\pm$ 17 ka and a U-series date of ca. 350 ka; Pécsi, 1990). As illustrated in Fig. 11, the Vértesszölös deposits are assigned to terrace V of the Tata River, which is thought to correlate with terrace V of the Danube and has been assigned an early Middle Pleistocene or 'Günz' age (e.g. Pécsi, 1990). The site has a complex stratigraphy (Pécsi, 1990) but the fluvial/colluvial interbeds forming Tata terrace V are ca. 35–45 m above present river level (Fig. 11), a position that is closely comparable to terraces of mid-Middle Pleistocene ages in other parts of Europe, such as the Somme (Fig. 3).

Probably the best guide to the age of the Vértesszölös deposits comes from mammalian biostratigraphy. The travertine has yielded a number of mammalian species that are believed to have become extinct in MIS 12, notably the vole *Pliomys episcopalis*, the rhinoceros *Stephanorhinus hundsheimensis* and the bear *Ursus deningeri* (Kretzoi, 1990; Jánossy, 1990). Critically, the water vole is *Arvicola cantiana* (e.g. Jánossy, 1990), which further constrains the age to late within the Cromerian Complex (cf. Preece and Parfitt, 2000). A final key indicator is the vole *Microtus gregalis*, which appears at Vértesszölös only in the upper part of the travertine and in overlying loess (Kretzoi, 1990; Jánossy, 1990). In southeast England this species is considered to have appeared in the latest Cromerian Complex (e.g. Preece and Parfitt, 2000), being notably present at Boxgrove, a site that is attributed to MIS 13

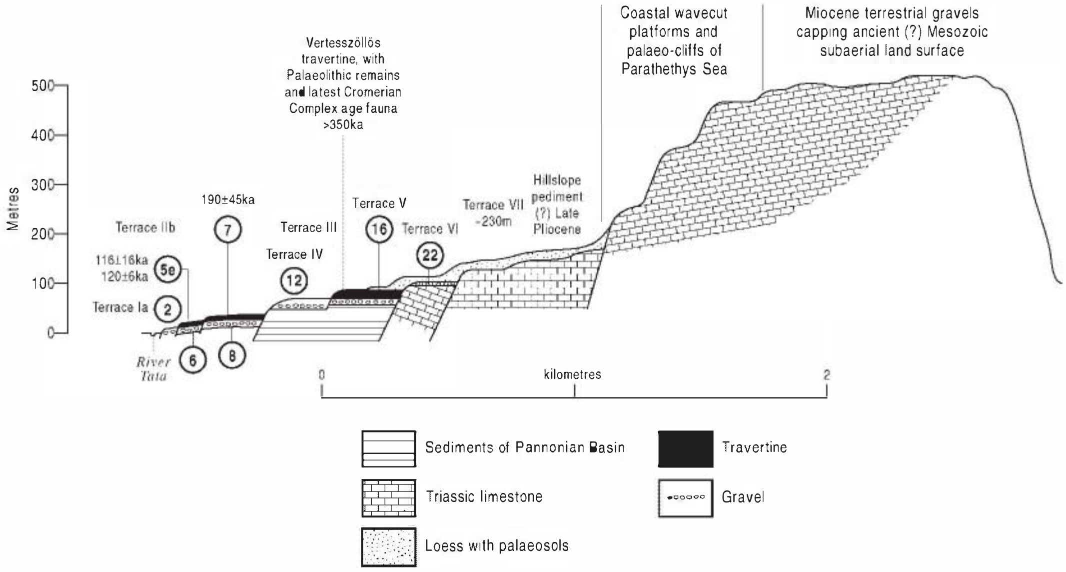

Figure 11 Transverse profile illustrating the terrace staircase morphology for the Danube and the Tata, its right-bank tributary, showing the stratigraphic position of the Vértesszölös Palaeolithic site (northwest Hungary) and older landforms, including Miocene 'marine' terraces of the landlocked Paratethys 'Sea'. Modified from Gascoyne and Schwarcz (1982). For location see Fig. 1

(Roberts and Parfitt, 1999), perhaps MIS 13a (Westaway *et al.*, in press).

The Caucasus and its surroundings

The earliest evidence of human occupation anywhere in Europe (in a broad sense) is provided by the well-documented Dmanisi site in Georgia (e.g. Gabunia and Vekua, 1995; Gabunia *et al.*, 2000; de Lumley *et al.*, 2002; Fig. 1), in the Lesser Caucasus Mountains. Human remains in fluvial and volcanogenic deposits at this site are securely dated to ca. 1.8 Ma from Ar-Ar dating of stratigraphically underlying and overlying basalt flows and from magnetostratigraphy that establishes normal polarity, indicating the Olduvai subchron. This site adjoins the confluence of the Mashavera and Pinezauri rivers, which now flow at a level ca. 90 m lower. Handaxes are absent at this site, which is characterised instead by flake artefacts typically made of either lithified tuff or quartz, materials that were locally available in this volcanic region, either *in situ* or from fluvial cobbles (Ljubin and Bosinski, 1995).

At Achalkalaki, further east in Georgia, Ljubin and Bosinski (1995) reported evidence from fluvial silt, in which abundant faunal remains suggest a butchery site, although only a single flake artefact has been reported. They placed this site around the Early to Middle Pleistocene boundary from the faunal evidence. There is abundant evidence of handaxe making in the Greater Caucasus from the later Cromerian Complex onwards, from cave sites such as Azych, Kudaro I and III and Treugol'naya (Ljubin and Bosinski, 1995), their interpretations reinforced by mammalian biostratigraphy and geochronology (Ljubin and Bosinski, 1995; Ljubin and Beliaeva, 2004; Derevianko and Petrine, 2004). The oldest site north of the western Caucasus is thought to be Cimbal quarry, Kurgan, in the Taman Peninsula (Ljubin and Bosinski, 1995; Fig. 1); a small number of flake artefacts has been found here in association with abundant mammal bones, some of which are broken, apparently by butchery. This site is thought from the mammal fauna to date from around the Early to Middle Pleistocene boundary (Ljubin and Bosinski, 1995; cf. Markova, 2005). At Gerasimovka, an assemblage of *LPMT* affinity is derived from a coarse fluvial gravel, now 45 m a.s.l., related to the outlet spillway, known as the Manych palaeochannel, which connected the Caspian Sea to the Black Sea during highstands of the former (Praslov, 1995; Mitchell and Westaway, 1999). Mammals from the gravel and overlying sand date the sequence to the Early to Middle Pleistocene transition.

Discussion

The value of Quaternary fluvial sequences as contexts for Palaeolithic artefacts has long been appreciated. However, it is only with better understanding of the Pleistocene climatic record, and by integration of data from different regions, that the full potential of this archive will be realised. Primary-context preservation is rare (although far from unknown) in fluvial settings, but the quantity of artefacts recovered is often considerable and can represent an excellent demonstration of human presence and activity, from which patterns of human movement and occupation can perhaps be determined. More than this, distinctive lithic signatures might have stratigraphical significance (as trace fossils). Crucially, the fluvial stratigraphical context can provide a valuable dating framework for regional interpretation and wider correlation of Palaeolithic archaeology. From the selected datasets reviewed here, it is possible to make a number of broad and preliminary statements.

The dating evidence now available, from cave sites as well as fluvial contexts, suggests that the earliest occupation of southern Europe was diachronous; oldest in the east, at ca. 1.8 Ma at Dmanisi in the Caucasus, but only ca. 1 Ma in Spain (Fuente Nueva-3). Data from Kozarnika cave, in northwest Bulgaria, fits this pattern, since humans reached here by ca. 1.4 Ma (Guadelli *et al.*, 2005). As already noted, the oldest site in Italy, Monte Poggiolo (near Forli in Emilia-Romagna), is thought to date from around the Jaramillo subchron (e.g. Antonazzi *et al.*, 1993); Pont-de-Lavaud (noted above) appears to be of comparable age or slightly younger. This earliest human population is represented by non-handaxe assemblages. The first evidence of handaxe-making in Iberia appears around the Matuyama–Brunhes transition (Fig. 8(a)). The handaxe makers may well have crossed the Gibraltar Strait from Morocco, where the earliest Acheulian assemblages appear to date from the latest part of the Matuyama chron (see above). However, handaxe making is also evident in the Levant by 1.4–1.2Ma (Bar-Yosef, 1998), presumably the route by which handaxe makers reached the Caucasus, and in India by 1.2 Ma (Petraglia *et al.*, 1999). Handaxes appeared in France in MIS 15–14 (e.g., Carpentier Quarry (?) and the Fréville Formation in the Somme) and in southern England in MIS 13 (e.g. Boxgrove, Waverley Wood).

A related issue concerns the possibility of human migration across the central Mediterranean Sea from Tunisia into Sicily and southern Italy. Early Middle Pleistocene archaeological sites in southern Italy, such as Notarchirico near Venosa in Basilicata (a fluvial site, River Ofanto, dated to 640 ± 40 ka from associated volcanic tephra; Piperno and Tagliacozzo, 2001) provide evidence of handaxe-making, whereas at contemporaneous sites further north, such as Isernia La Pineta (also dated to ca. 600 ka; e.g. Minelli and Piretto, 2005; Fig. 1), there is no evidence of handaxe-making and only flake artefacts are known.

In contrast, the *LPMT* assemblages that characterise eastern and central Europe during the Middle Pleistocene, at sites such as Vértesszölös, Racineves, Schöningen and Bilzingsleben, as well as Pogrebya in eastern Moldova (anczont and Madeyska, 2005), suggest the presence of a distinct tool-making repertoire in that region.

After the introduction of handaxe technology into western Europe at ca. 600ka, it can be envisaged that, in response to climatic cyclicity, the limits of human occupation would have repeatedly fluctuated northward and southward and also eastwards and westwards. During glacial maxima, populations can be presumed to have retreated southward to *refugia* in southern France and Iberia, returning north when conditions were less hostile. Presumably something similar was also occurring in the non-handaxe-making populations of central and eastern Europe, with the *refugia* located in the Balkans. Evidently, Britain lay close to the limit typically reached by both populations, thus explaining the alternation of handaxe and non-handaxe assemblages in the archaeological record of southern England (cf. Breuil, 1932; Wymer, 1968; White and Schreve, 2000), a plausible consequence of the wider European picture. This pattern of cyclic retreat of populations into distinct southwest- and southeast-European refugia has an analogue in the movement of the population of modern humans during the last glaciation, as revealed by molecular genetics (e.g. Achilli *et al.*, 2004; Rootsi *et al.*, 2004).

Conclusions

The review of fluvially based evidence for early human distribution and activity in Europe, presented here, is only part of a broader picture emerging from the IGCP 449 data collections, with additional information also available from Africa and Asia that will be reviewed elsewhere. Nonetheless, fluvial sequences provide a valuable framework and context for the early Palaeolithic archaeological record from Europe, allowing the timings of different immigration pulses, of people with different lithic traditions, to be unravelled. Many of the important sites are from non-fluvial environments, with cave sediments generally providing richer, better preserved and/or more readily dated assemblages of both artefacts and fauna. Cave deposits, however, occur in geographical and chronological isolation within the geological record. If they can be correlated, preferably by multiple means (cf. Bridgland *et al.*, 2004a), with a regional fluvial record that extends through much of the Quaternary, their geological context will inevitably be enhanced. Beach deposits, which can also be repositories for archaeological data, can also form part of lengthy Quaternary sequences, but are of course restricted to coastal regions. Fluvial records can extend the contextual framework into continental interiors.

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