Southminster, Goldsands Road Pit

[TQ 961 991]

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Highlights

This pit exposes typical gravel of the post-diversion Thames-Medway, deposited by the Thames, downstream from its confluence with the Medway, as it flowed north-eastwards across this part of Essex. This stretch of the river's course was formerly part of the Medway valley but was adopted by the Thames upon its diversion. The Asheldham Gravel at Southminster is believed to equate with both the Black Park Gravel and the Boyn Hill Gravel of the Middle Thames (the former underlying the latter in the Southminster area), the first two formations to be deposited by the river after its diversion during the Anglian Stage.

Introduction

Exposures at Goldsands Road Pit, Southminster, reveal the Asheldham Gravel, the highest and oldest formation of the Low-level East Essex Gravel Subgroup, which is attributed to the post-diversion Thames-Medway (Bridgland, 1983a, 1983b, 1988a; (Figure 5.5)B and (Figure 5.15). This formation is broadly equivalent to both the Southminster and Asheldham Terrace gravels of Gruhn *et al.* (1974) and to the '3rd Terrace' of the Geological Survey (Lake *et al.,* 1977, 1986).

Southminster lies in the south-eastern corner of the Dengie Peninsula, which separates the Crouch and Blackwater estuaries. The Asheldham Gravel is the most extensively preserved terrace formation on this peninsula, largely because later Thames-Medway deposition seems to have been confined, onshore, to the area further south. Higher deposits to the west belong to the High-level East Essex Gravel Subgroup, the product of the tributary Medway system ((Figure 5.15) and (Figure 5.16); see above, Introduction to Part 2). The Asheldham Gravel forms an almost continuous sheet, averaging approximately 1 km in width, between Burnham-on-Crouch and Bradwell, dissected only by small streams flowing eastwards into the North Sea (Figure 5.15). Geological Survey borehole data and subdrift contour mapping (Lake *et al.,* 1977; Simmons, 1978) show that over much of the area the Asheldham Gravel overlies a substantial buried channel, the Asheldham Channel (Figure 5.28). Boreholes have revealed that this channel contains localized fossiliferous sediments, but scientific evaluation of these has only recently been undertaken (H.M. Roe, pers. comm.) and results have yet to be published.

Description

The exposures in the Goldsands Road Pit show mainly matrix-supported, massive and cross-stratified sandy gravel, interbedded with sands and clayey sands (Figure 5.29). These sediments essentially comprise upper and lower gravel units, separated by ripple-drift-laminated and cross-bedded sands (Bridgland, 1983a, 1983b). Palaeocurrent measurements from the sands indicate flow to the east-north-east. In a large part of the pit the sands and gravels are overlain by 1.5 m of silty clay (brickearth), containing scattered pebbles. This may be either a flood-plain (overbank) deposit or a colluvial accumulation and, except for the pebbles, has an appearance similar to weathered London Clay. These deposits, with the exception of the clay, are typical of the products of a braided-river environment (Miall, 1977), the range of sediment types suggesting deposition on longitudinal and linguoid bars. The original land surface in the vicinity of the pit was probably between 20 m and 21 m O.D., rising north-westwards to 25 m O.D. in the middle of Southminster [TQ 956 998], well within the mapped range of the Asheldham Gravel.

A total thickness of over 4.5 m of Pleistocene sediments overlies London Clay at 15.5 m O.D. in the GCR site. Gruhn and Bryan, who worked here at a time of more extensive quarrying, reported a sloping 'bench' beneath the gravel of the area, ranging between 9.7 and 10.7 m O.D., with the highest bedrock level in the north-east (Gruhn *et al.,* 1974, unpublished appendix). Three Geological Survey boreholes in the vicinity add to the general picture of variable relief. A borehole to the north-west of Goldsands Road Pit showed 3.8 m of sandy, silty clay and soil, overlying 2.4 m of gravel, the London Clay being reached at 14.4 m O.D. Another, 350–400 m to the south-west, showed only 3 m of Pleistocene sediments overlying the London Clay at 16.3 m O.D. The third borehole, near Newmoor [TL 9964 0035], to the north of Southminster, revealed 10.5 m of gravel overlying the London Clay at 10.8 m O.D. (Simmons, 1978). This bedrock surface information suggests that the deposits fill a channel eroded into the London Clay, the eastern side of which appears to be preserved beneath the eastern edge of the Asheldham Gravel outcrop (Figure 5.28). This contradicts the subdrift contour maps published by the Geological Survey (Lake *et al.,* 1977; Simmons, 1978), which suggest that the eastern side of the channel has been removed by later erosion.

Interpretation

Clast-lithological analysis of the Asheldham Gravel at Southminster reveals the combination of local, southern and exotic lithologies that characterizes the Low-level East Essex Gravel Subgroup (Bridgland, 1983a, 1983b, 1988a; (Table 5.5)). In comparison with the High-level East Essex Gravel deposits, which lie to the west and at a greater elevation, the Asheldham Gravel contains rather more local material (84–91%) and significantly less southern material (7.8–13.5%). The occurrence of a number of pebbles of Ightham Stone and Hastings Beds lithologies (Bridgland, 1983a, 1986b) indicates a continued Medway influence, these being derived from north Kent and the central Weald respectively. Most significant, however, is the appearance of an exotic component (1.4–2.25%) in the Asheldham Gravel, including all the types characteristic of the Lower Thames gravels of the Tilbury area (see Chapter 4): predominantly quartz, quartzites, Carboniferous chert and *Rhaxella* chert. The appearance of this characteristic exotic suite in the Asheldham Gravel marks the initiation of Thames drainage in this part of eastern Essex, which resulted from the Anglian diversion of the river (see above, Introduction to Part 2).

The buried channel underlying the Asheldham Gravel, revealed by various bedrock surface data, is part of a complex feature recognized by Lake *et al.* (1977) as their 'Burnham Buried Channel'. However, the feature they described incorporates a deep channel, eroded to well below ordnance datum, beneath 'First Crouch Terrace' (Barling/Dammer Wick Gravel) deposits in the Burnham-on-Crouch area (see (Figure 5.15) and (Figure 5.28)). This deep channel is here attributed to later incision, which has partly dissected the earlier deposits. Although the name Burnham Channel has previously been used for the older channel beneath the Asheldham Gravel (Bridgland, 1983a, 1983b), it is now restricted to the later, deeply incised feature. The Burnham Channel has been interpreted as a downstream continuation of the Shoeburyness Channel of the Southend area (Bridgland, 1988a; (Figure 5.5)C). Little is known of the sediments filling this feature, but the bivalve *Corbicula fluminalis* is known both from Shoeburyness (Whitaker, 1889; Kennard and Woodward, 1907) and from a borehole at East Wick, Burnham-on-Crouch (Warren, 1951), possibly from the channel(s) in question. The occurrence of this bivalve might be an indication of deposition in a temperate episode pre-dating the Ipswichian Stage (*sensu* Trafalgar Square); in other words, pre-Oxygen Isotope Stage 5 (see Chapter 2, Stanton Harcourt and Magdalen Grove). A correlation between the Shoeburyness/Burnham Channel Deposits and the Mucking Formation of the Lower Thames was suggested by Bridgland (1988a). However, following a recent revision of terrace correlation between the Lower Thames and the Southend area (Bridgland *et al.,* 1993), the Shoeburyness/Burnham Channel is thought to be a downstream equivalent of the interglacial Thames channel recognized within the Corbets Tey Formation in the Ockendon–Purfleet area, which suggests correlation with the Oxygen Isotope Stage 9 temperate episode (see Chapter 4, Purfleet; (Table 1.1) and (Table 4.1).

The older channel, underlying the Asheldham Gravel, has been redefined as the Asheldham Channel (Bridgland, 1988a). The deposits filling this channel comprise a basal gravel (Ash-eldham Channel Gravel) and an overlying sequence of fine-grained, fossiliferous deposits (Asheldham Channel interglacial deposits). The type locality for these units (and for the Asheldham Gravel) is a gravel pit at Asheldham [TQ 971 917], which overlies the central part of the channel (Bridgland, 1983a). Again, little is known about the fossiliferous channel sediments; clays, silts and sands recorded in boreholes near Bradwell at [TL 9872 0581] and [TL 9971 0657] revealed silty deposits with 'shell and reed beds' and 'carbonaceous material' respectively (Simmons, 1978). The distribution and elevation of these channel deposits strongly suggest correlation with those to the north of the Blackwater, at Cudmore Grove and Clacton (Bridgland, 1988a; (Figure

1.3) and (Figure 5.5)A.

The deposits to the west of Southminster and at Asheldham, which, at up to 25 m O.D., are the highest within the Asheldham Gravel (Bridgland, 1983a), were assigned by Gruhn *et al.* to their Asheldham Terrace. Other deposits now included in the Asheldham Gravel, those at Burnham, to the east of Southminster, west of Tillingham and south-west of Bradwell, have considerably lower surface elevations and were included by Gruhn *et al.* in their Southminster Terrace. Their long-profile diagram (Gruhn *et al.,* 1974, fig. 10) showed these two terraces as vertically overlapping aggradations with an altitudinal separation of 3–5 m. However, the more detailed bedrock surface information available as a result of the recent Geological Survey borehole programme indicates that the differences in bedrock surface level, interpreted by Gruhn *et al.* as evidence for two distinct terraces, merely reflect different positions relative to the cross-profile of the Asheldham Channel. Indeed, the upper part of the Asheldham Gravel extends laterally away from the channel in a number of areas and overlies a separate, higher 'bench' (Bridgland, 1983a). The difference in surface level between gravels assigned by Gruhn *et al.* to their Asheldham and Southminster Terraces probably results, therefore, from differential erosion. Thus the deposits underlying both terraces can be variously reinterpreted as Asheldham Gravel or Asheldham Channel Gravel (Figure 5.15). It is apparent that the Asheldham Terrace represents the maximum aggradational level of the Asheldham Formation, whereas areas attributed by Gruhn *et al.* to their Southminster Terrace have been lowered by later erosion; the latter term should no longer be used, therefore.

Consideration of its elevation suggests that the lower part of the sequence observed at Southminster may belong to the Asheldham Channel Gravel rather than the Asheldham Gravel. The interglacial sediments that separate the Asheldham Channel Gravel and the Asheldham Gravel are not present throughout the area; where they are absent, distinction between the two gravel units is extremely difficult. Fine-grained sediments occur between lower and upper gravels at Goldsands Road Pit, but it is impossible to ascertain whether these occupy the stratigraphical position of the Asheldham Channel interglacial deposits. There is nothing in the clast composition of samples collected from the lower and upper gravels (Table 5.5) to support any distinction between the units on this basis, but no lithological separation is generally possible between the various formations of the Low-level East Essex Gravel Subgroup (Bridgland, 1983a, 1988a).

A further piece of evidence of possible relevance to the identity of the lower gravel unit is the discovery in it of the butt-half of a rolled hand-axe by P. Harding (Bridgland, 1983a, p. 227; Wymer, 1985b). Two such broken artefacts were in fact discovered at the site during the cleaning of the sections for the visit of the Quaternary Research Association in April 1983, a broken point of a hand-axe, less rolled, being recovered from the upper gravel on the same occasion. The occurrence of hand-axes (Acheulian Industry) in the Asheldham Gravel is no surprise; numerous examples are recorded from its upstream equivalents, the Southchurch Gravel of the Southend area (Bridgland, 1983a; Wymer, 1985b), the Orsett Heath Gravel of the Lower Thames (Chapter 4) and the Boyn Hill Gravel of the Middle Thames (Chapter 3). The Asheldham Channel Gravel, on the other hand, is believed to correlate (Bridgland, 1988a; (Table 1.1) and (Figure 1.3)) with the Swanscombe Lower Gravel and the basal gravel of the Clacton Channel (Lower Freshwater Beds), both of which contain abundant Clactonian artefacts but no hand-axes (excluding a very few, possibly unreliable records — see above, Clacton). The Asheldham Channel Gravel has itself yielded a small assemblage of Clactonian artefacts, collected by Warren (1933) from a site at Burnham-on-Crouch (Wymer, 1985b; Bridgland, 1988a). The apparent association of Clactonian material with the pre-interglacial and early interglacial parts of the Asheldham Formation (phase 2 and early phase 3 of the climatic terrace model — see Chapter 1) may indicate that the lower gravel at Southminster, which has yielded a hand-axe, post-dates the interglacial. However, there is good evidence to suggest that hand-axe makers occupied the Thames valley prior to the Clactonian occupation represented by the Swanscombe and Clacton industries, as has been discussed above (see Clacton). Three rolled, probable hand-axe finishing flakes were, in fact, found amongst the material collected in the second golf course excavation at Clacton (Singer *et al.,* 1973; Wymer, 1985b), implying that derived Acheulian material is to be expected in the Asheldham/Clacton Channel Gravel. The hand-axes from Southminster may therefore have no stratigraphical significance, other than indicating that the gravel post-dates the earliest occupation of southern Britain by Palaeolithic Man.

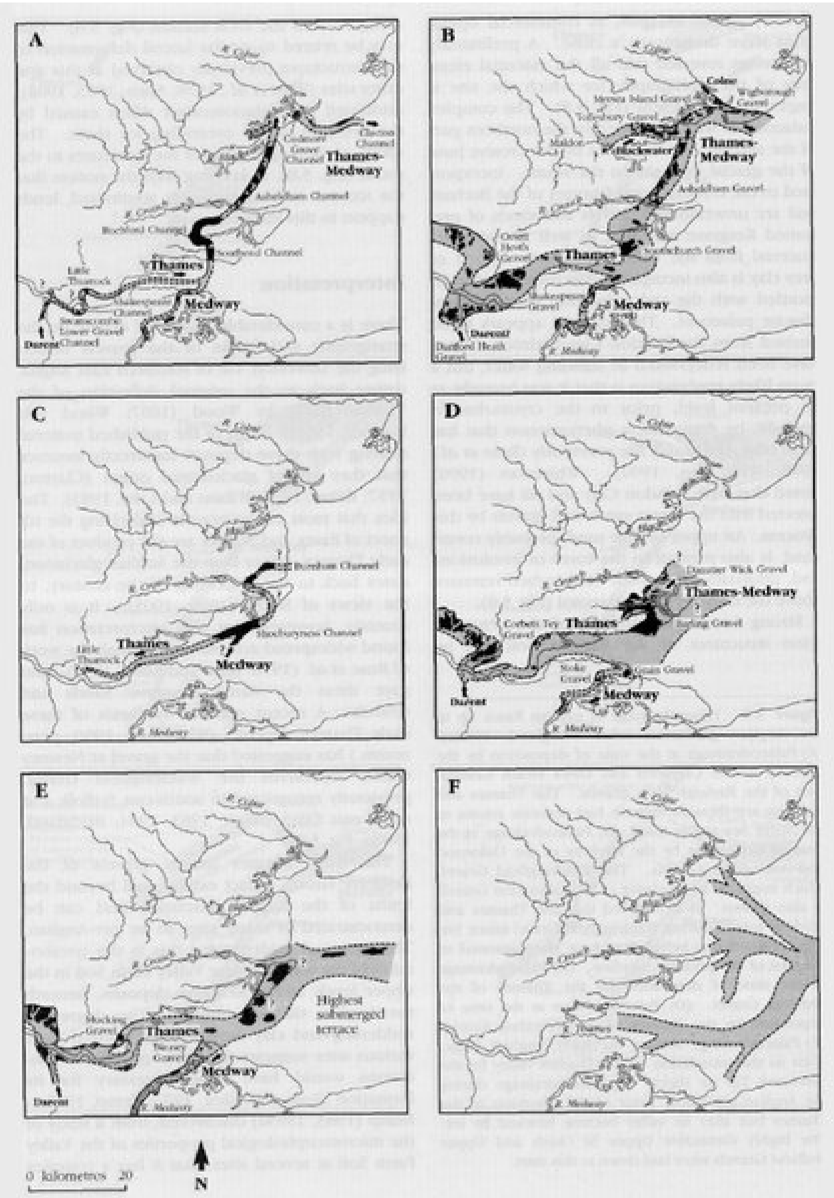
The correlations proposed in this volume, based on terrace stratigraphy, imply that aggradation of the Asheldham Formation spanned the period from the late Anglian (late Oxygen Isotope Stage 12) to early Oxygen Isotope Stage 10, when rejuvenation to the level of the Barling Formation occurred (Chapter 1). The Asheldham Formation and its upstream correlative in the Lower Thames, the Orsett Heath Formation, are considered to correlate with the Boyn Hill

Formation of the Middle Thames (see Chapter 4). They are also believed to incorporate, in their lower parts, downstream equivalents of the late Anglian Black Park Gravel of the Middle Thames, the earliest post-diversion formation, which appears to have been graded to a very low base level (see Chapter 4, Wansunt Pit). It must be emphasized that the degree of complexity implied by this interpretation is indicated by regional stratigraphical evidence (summarized in (Table 1.1)) and cannot, as yet, be determined from the sediments of the Asheldham Formation at Southminster or elsewhere.

Conclusions

Fluvial gravels occurring at this locality contain a mixture of rocks from Kent, to the south, and from the north-west, carried down the main Thames valley. This is because they were deposited by the combined Thames-Medway river, formed by the confluence of the Medway and the Thames in the area south of Southend. Older deposits in the Southminster area show that this part of Essex was formerly in the Medway valley, at a time when that river extended from Kent to the Clacton area, where it joined the old (pre-diversion) Thames. When diverted, the Thames adopted the old Medway valley between Southend and Clacton, depositing gravels of the type found at Southminster. The GCR site at Goldsands Road Pit provides exposures in the Asheldham Gravel and, possibly, in the Asheldham Channel Gravel. The study of these deposits is of considerable importance in reconstructing the evolution of the river system in this area during the Middle Pleistocene. This area of eastern Essex provides an important link between the Lower Thames sequence, with its abundance of fossiliferous and Palaeolithic sites, and the Tendring Plateau, where a comparable wealth of information also exists.

References



(Figure 5.5) Palaeodrainage of Essex following the Anglian glaciation (modified from Bridgland, 1988a). (A) Palaeodrainage during the filling of the Southend/Asheldham/Clacton Channel. The Swanscombe Lower Gravel Channel and the Cudmore Grove Channel are both thought to be lateral equivalents. The Rochford Channel is now thought to represent an overdeepened section of the same feature (see text). This channel was excavated in the late Anglian by the newly diverted Thames and filled during the Hoxnian Stage (sensu Swanscombe). (B) Palaeodrainage during the deposition of the Southchurch/Asheldham Gravel.. This aggradational phase is believed to have culminated during the earliest part of the Saalian Stage, early in Oxygen Isotope Stage 10. (C) Palaeodrainage during the filling of the Shoeburyness Channel. The channel beneath the Corbets Tey Gravel of the Lower Thames is believed to be an upstream equivalent of this feature. It is thought that both the excavation and filling of the channel were intra-Saalian events, dating from Oxygen Isotope Stages 10 and 9 respectively. (D) Palaeodrainage during the deposition of the Barling Gravel. This is regarded as an intra-Saalian deposit, aggraded during Oxygen Isotope Stage 8. (E) Palaeodrainage during the deposition of the Mucking Gravel of the Lower Thames. The Thames-Medway equivalent of this formation is buried beneath the coastal alluvium east of Southend and can be traced offshore (Bridgland et ed., 1993). This aggradational phase occurred towards the end of the complex Saalian Stage, culminating early in Oxygen Isotope Stage 6. (F) Palaeodrainage during the last glacial. The submerged valley of the Thames-Medway has been recognized beneath Flandrian marine sediments in the area offshore from eastern Essex (after D'Olier, 1975).

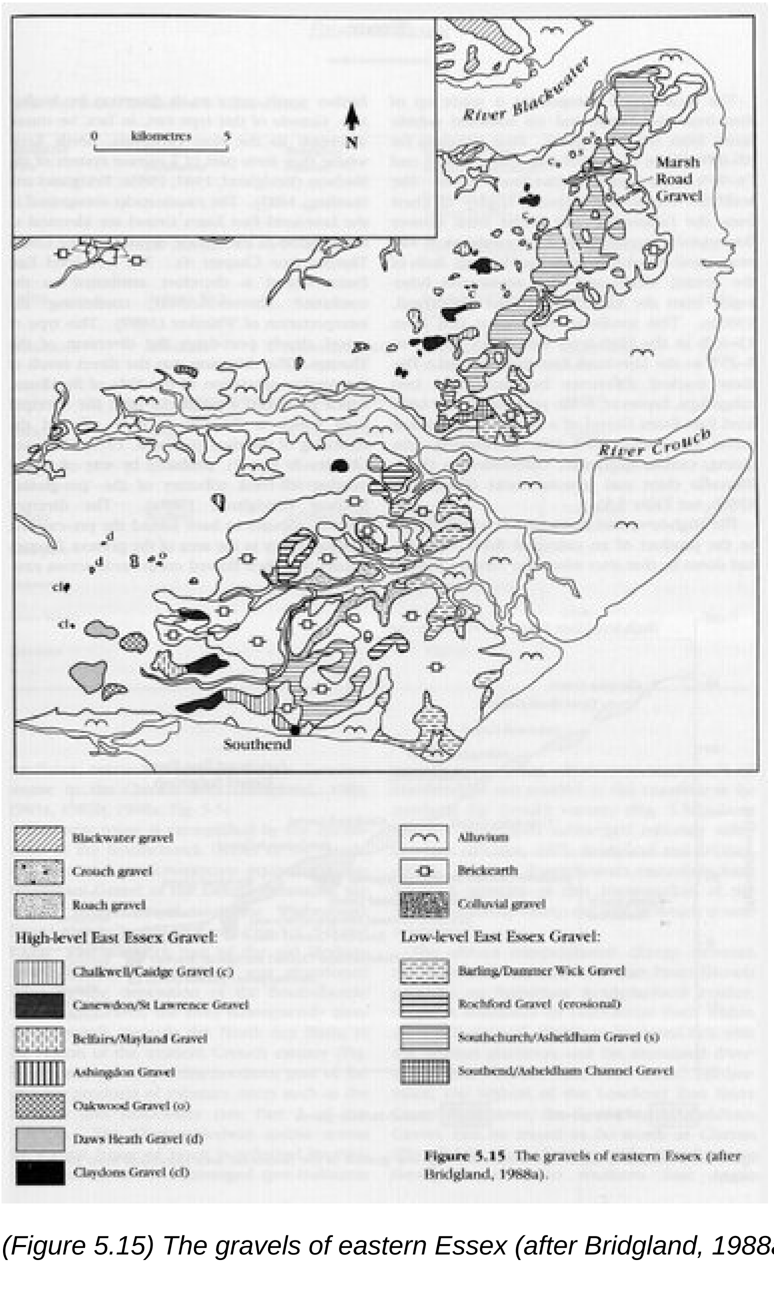
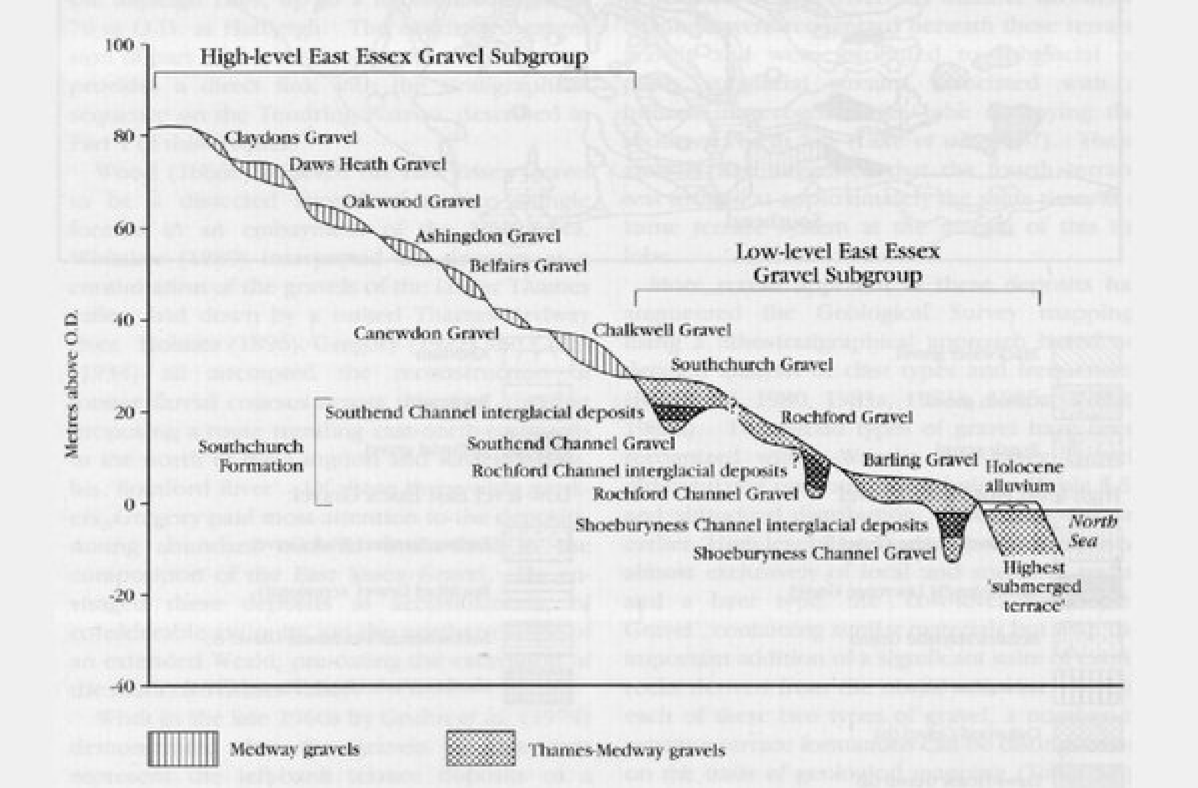
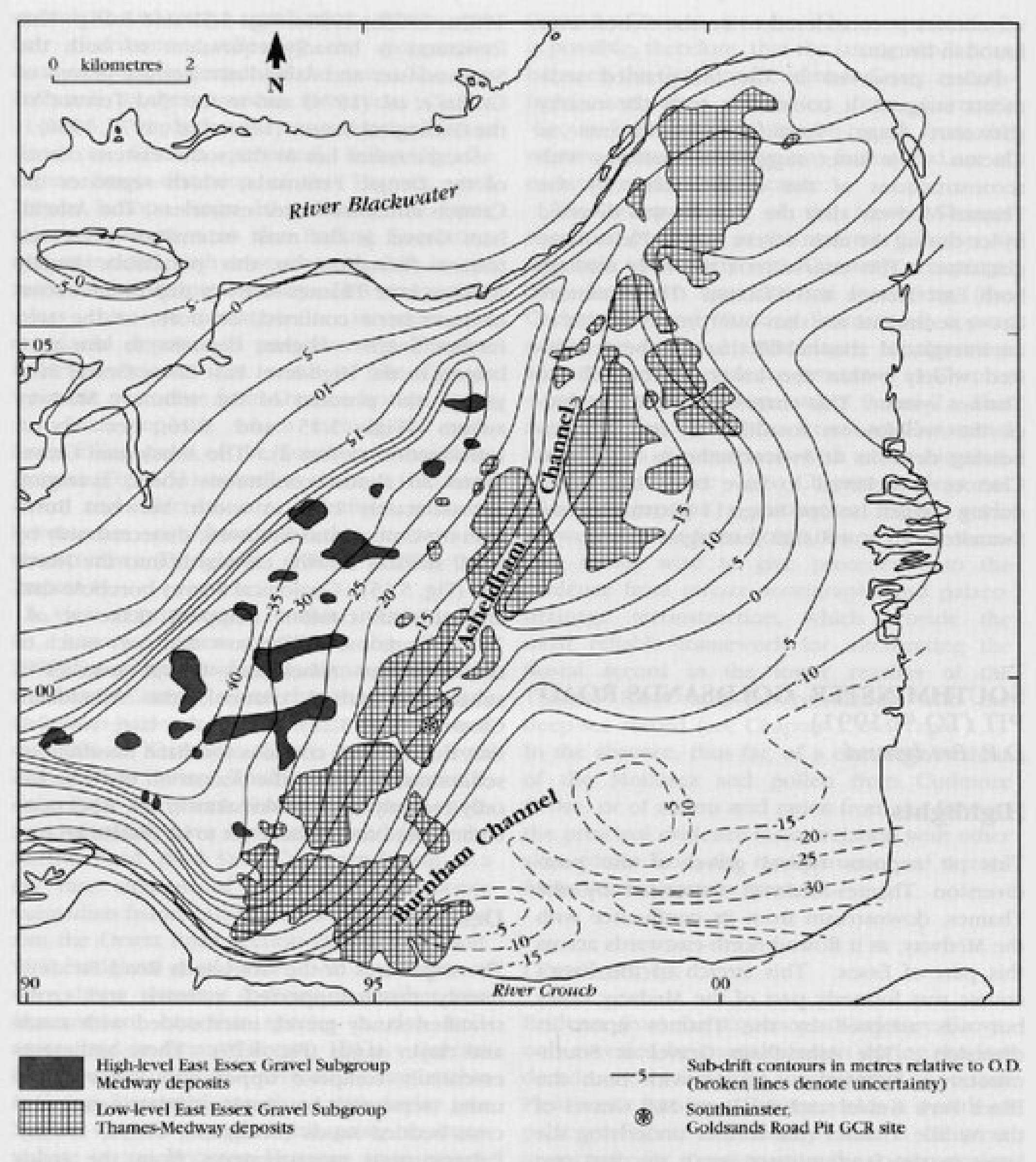


Figure 5.15 The gravels of eastern Essex (after Bridgland, 1988a).

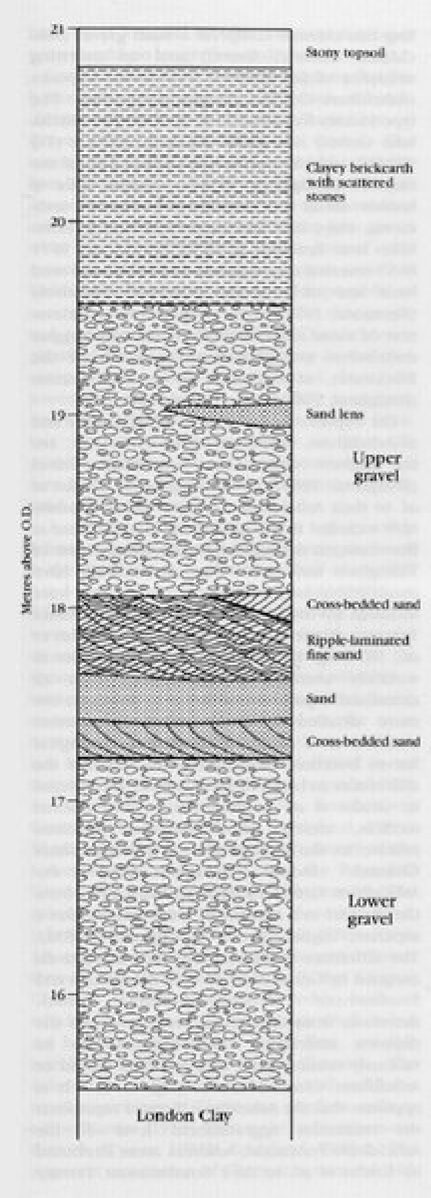
(Figure 5.15) The gravels of eastern Essex (after Bridgland, 1988a).



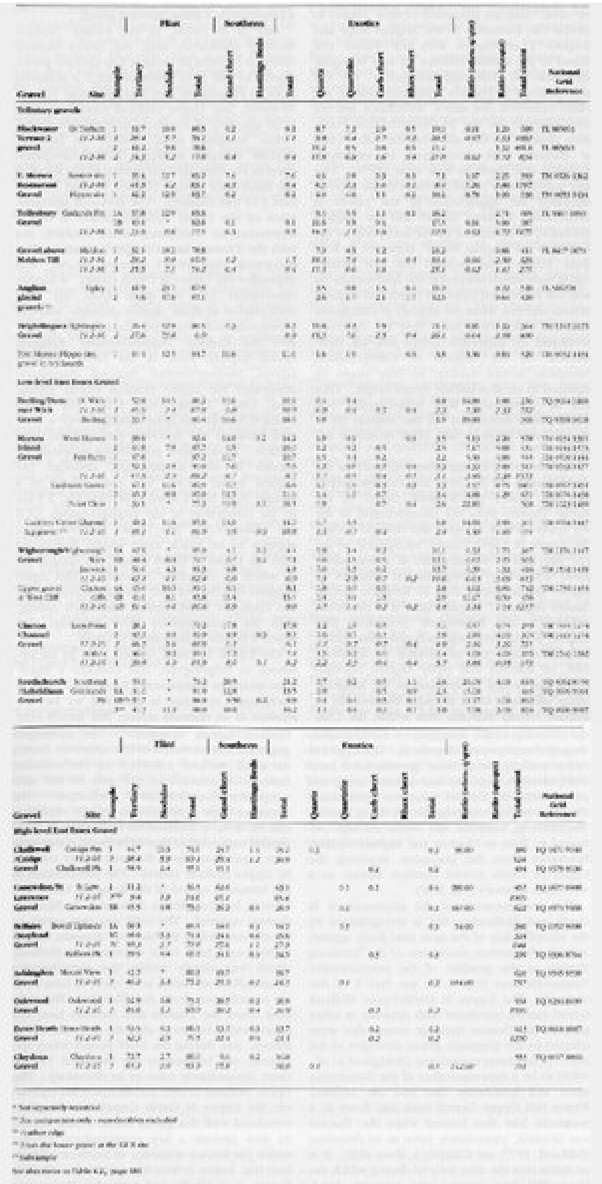
(Figure 5.16) Idealized transverse section through the gravels of the Southend area (modified from Bridgland, 1988a).



(Figure 5.28) Map showing the outcrop of the Asheldham Gravel and bedrock surface contours, revealing the form of the Asheldham Channel (modified from Lake et al., 1977).



(Figure 5.29) Section at Goldsands Pit. This shows the division into upper and lower gravels, separated by cross-bedded and ripple-laminated sands.



(Table 5.5) Clast-lithological composition of gravels described in Chapter 5, Parts 2 and 3.

Age (in thousands of years)	Upper Thames	Middle Thames	Lower Thames	Essex	Stage	^{18}O
	Recent floodplain and channel deposits. Holocene alluvium of floodplain and coast				Holocene	1
10						
	Northmoor Gravel	Shepperton Gravel	Submerged	Submerged	late Devensian	2-4
	Rejuvenation event					
71						
		Temperate climate deposits at South Kensington (Isleworth and Kempton Park	Submerged	Submerged	early/mid Devensian? interstadial(s)	5a &/or 5c?
?						
	Cold climate gravels above Eynsham Gravel	**Reading area**: U. levels of Taplow Gravel **Slough area**: Kempton Park Gravel	East Tilbury Marshes Gravel	Submerged	early-mid Devensian	5d-2
122						
	Eynsham Gravel	**Reading area**: Within Taplow Formation **Slough area**: Trafalgar Square and Brentford deposits	Below floodplain	Submerged	Ipswichian (sensu Trafalgar Square)	5e
128						
	Stanton Harcourt Gravel	**Reading area**: Taplow Gravel **Slough area**: Basal Kempton Pk Gravel - incl. Spring Gardens Gravel of Gibbard (1985)	Basal East Tilbury Marshes Gravel	Submerged	late Saalian	6
	Rejuvenation event					
		Taplow Gravel	Mucking Gravel			
186						
	Stanton Harcourt Channel Deposits, interglacial Magdalen Grove, Summertown etc.	Interglacial deposits at Redlands Pit, Reading	Interglacial deposits at Aveley, Ilford (Uphall Pit), West Thurrock, Crayford and Northfleet	Submerged	Intra-Saalian temperate episode	7
245						
	Basal Summertown-Radley Formation at some sites?	Basal Taplow Gravel?	Basal Mucking Gravel	Submerged		
	Rejuvenation event				mid-Saalian	8
	Wolvercote Gravel at some sites?	Lynch Hill Gravel	Corbets Tey Gravel	Barling Gravel		
303						
	Wolvercote Channel Deposits		Interglacial deposits at Ilford (Cauliflower Pit), Belhus Park, Purfleet and Grays	Shoeburyness Channel interglacial deposits	Intra-Saalian temperate episode	9
339						
	Basal Wolvercote Gravel	Basal Lynch Hill Gravel?	Basal Corbets Tey Gravel	Shoeburyness Channel - basal gravel		
	Rejuvenation event				early Saalian	10
	? Moreton Drift (Arkell, 1947a)					
	Hanborough Gravel	Boyn Hill Gravel	Orsett Heath Gravel	Southchurch/Asheldham/Mersea Island/Wigborough Gravel		
?						
	Reworked mammalian fauna in Hanborough Gravel		Swanscombe deposits	Southend/Asheldham/Cudmore Grove/Clacton Channel Deposits	Hoxnian (sensu Swanscombe)	11
423						
	Basal Hanborough Gravel?	Basal Boyn Hill Gravel?	Basal Orsett Heath Gravel (incl. Basal Gravel at Swanscombe)	Southend/Asheldham/Cudmore Grove/Clacton Channel - basal gravel	Anglian	12
	Rejuvenation event					
	Freeland Formation	Black Park gravel				
	Moreton Drift?	Anglian glacial deposits	Hornchurch Till	U. St Osyth/U. Holland Gravel		
	Freeland Formation	Winter Hill/Westmill Gravel	Valley did not exist as a Thames course prior to this	St Osyth/Holland Formation		
478						
	Sugworth Channel Deposits	Rassler Gravel?		Wivenhoe/Cooks Green Fm Ardleigh/St Osyth Formation Waldringfield Gravel	Cromerian Complex	21-13
?						
	Combe Formation	Gerrards Cross Gravel		Bures Gravel*	Early Pleistocene	pre-21
	Higher divisions of the Northern Drift Group	Beaconsfield Gravel Satwell Gravel gravel at Chorleywood Westland Green Gravels Stoke Row Gravel Nettlebed Gravel Nettlebed interglacial deposits		Moreton Gravel* Stebbing Gravel*		

* Nomenclature for High-level Kesgrave Subgroup in Essex follows Whiteman (1990).

(Table 1.1) Correlation of Quaternary deposits within the Thames system. Rejuvenations that have occurred since the Anglian glaciation are indicated.

Formation *etc* (First publication)	Type locality (National Grid Ref.)	Middle Thames equivalent	Stage	^{18}O
East Tilbury Marshes Gravel (Bridgland, 1983b)	East Tilbury Marshes (TQ 688784)	Kempton Park Gravel	mid to late Devensian	6-2[7]
(West Thurrock Gravel) (Gibbard *et al*., 1988)[6]	Lion Pit tramway cutting (TQ 597779)	(Reading Town Gravel)[6]	(early Devensian)	(?5d)
Interglacial Beds at Trafalgar Square		Brentford deposits[5]	Ipswichian	5e
Mucking Gravel (Bridgland, 1983b)	Mucking (TQ 689815)	Taplow Gravel	late Saalian	8-6[4]
Interglacial beds at West Thurrock, Aveley etc.			Intra-Saalian	7
Corbets Tey Gravel (Gibbard, 1985)	Corbets Tey (TQ 570844)	Lynch Hill Gravel	mid-Saalian	10-8[3]
Interglacial beds at Purfleet and Grays			Intra-Saalian	9
Orsett Heath Gravel (Bridgland, 1983b)	Orsett Heath (TQ 668803)	Boyn Hill Gravel	early Saalian	12-10[2]
Interglacial beds at Swanscombe			Hoxnian *sensu* Swanscombe	11[2]
(Dartford Heath Gravel) (Gibbard, 1979)[1]	Wansunt Pit (TQ 5147360)	(?Black Park Gravel)	(late Anglian)	(12)

1 The separate existence of the Dartford Heath Gravel, the subject of a lengthy controversy, is doubtful (see Wansunt Pit). This is thought to be part of the late Anglian to early Saalian Orsett Heath Formation.

2 The Boyn Hill/Orsett Heath Formation includes the interglacial sediments at Swanscombe, here attributed to ^{18}O Stage 11 (referred to as Hoxnian *sensu* Swanscombe in this volume).

3 Aggradation of the terrace deposits included within the Corbets Tey Formation began prior to the interglacial represented at Purfleet and Grays.

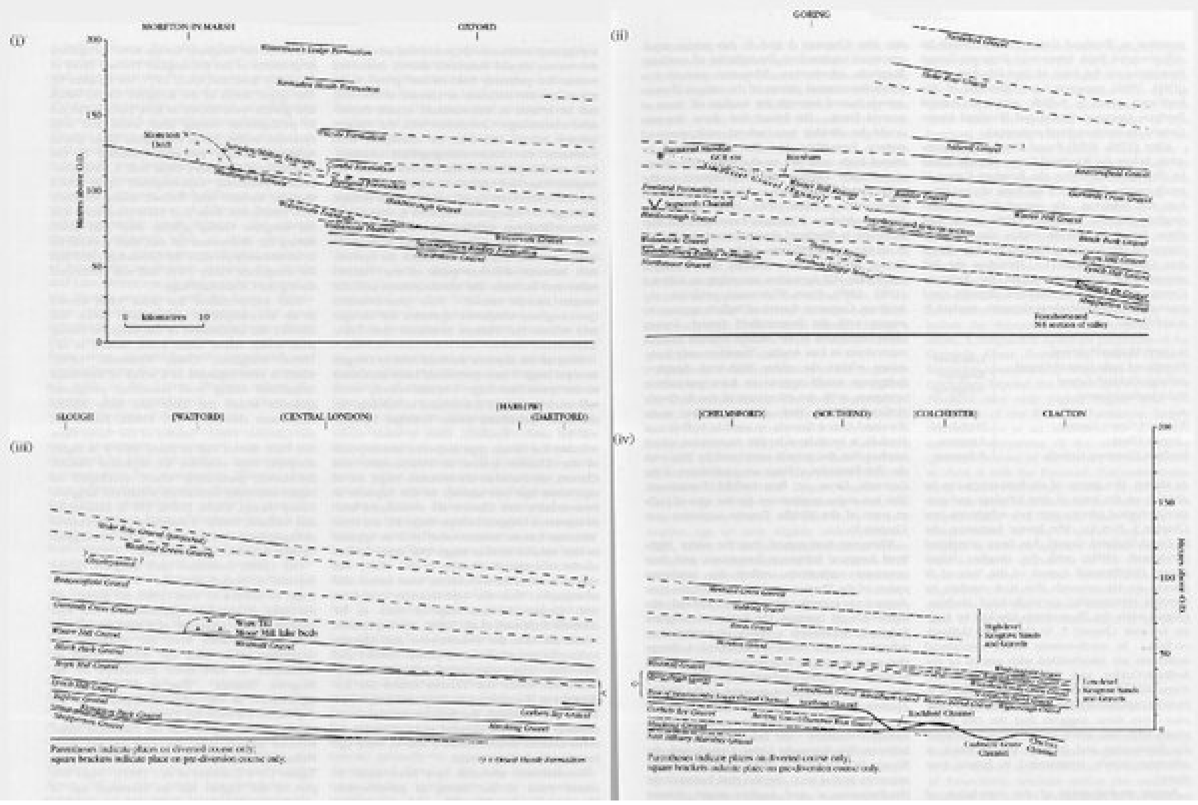
4 Aggradation of the terrace deposits included within the Mucking Formation began prior to the interglacial represented at West Thurrock, Aveley etc.

5 Described by Trimmer (1813) and Zeuner (1959).

6 The separate existence of the West Thurrock and Reading Town Gravels is disputed in this volume. These are believed to be part of the late Saalian Taplow/Mucking Formation (see West Thurrock and Fern House Pit).

7 The Ipswichian sediments at Trafalgar Square and Brentford are regarded here as part of the Kempton Park Formation (see Chapter 3, Fern House Pit). This formation is considered to represent aggradation from the end of Stage 6 (gravel underlying the Trafalgar Square sediments, the Spring Gardens Gravel of Gibbard, 1985) to the mid-Devensian.

(Table 4.1) The Pleistocene fluvial sequence in the Lower Thames (first published usage of lithostratigraphical terms in reference given in parentheses), with proposed correlations with the Middle Thames sequence, Pleistocene stages and oxygen isotope stages.



(Figure 1.3) Longitudinal profiles of Thames terrace surfaces throughout the area covered by the present volume. The main sources of information used in the compilation of this diagram are as follows: Arkell (1947a, 1947b), Briggs and Gilbertson (1973), Briggs et al. (1985), Evans (1971) and Sandford (1924, 1926) for the Upper Thames; Gibbard (1985) and Sealy and Sealy (1956) for the Middle Thames; Bridgland (1983a, 1988a) and Bridgland et al. (1993) for the Lower Thames and eastern Essex; Whiteman (1990) for central Essex.