Wivenhoe Gravel Pit

[TM 005 235]

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Highlights

At Wivenhoe, periglacial Thames gravels both underlie and overlie an organic silty clay that contains the remains of temperate-climate plants and beetles. It is believed that this entire sequence pre-dates the Anglian glaciation, which would suggest that the temperate interval represented falls within the 'Cromerian Complex' as recognized in The Netherlands.

Introduction

Wivenhoe Gravel Pit is located near the southern edge of the Tendring Plateau, *c.* 2 km from the estuary of the River Colne. Deposits classified as part of the Kesgrave Sands and Gravels (Rose *et al.,* 1976) have been exploited here for many years, old workings covering around half a square kilometre. The site is now regarded as the type locality for the Wivenhoe Gravel, which is chronologically the third of the four terrace formations (Figure 5.2) and (Figure 5.3) that constitute the Low-level Kesgrave Subgroup (Bridgland, 1988a; see above, Introduction to Part 1).

Recent appraisal of the site has revealed fossiliferous sediments apparently interbedded with the Wivenhoe Gravel (Bridgland *et al.,* 1988; (Figure 5.13)). These sediments have yielded pollen from temperate-climate trees, together with other plant fossils and beetle remains. The biostratigraphical evidence is as yet insufficiently distinctive to identify any particular temperate episode.

The stratigraphical position of the fossiliferous sediments at Wivenhoe is highly significant. They occur within a terrace formation (the Wivenhoe/Cooks Green Gravel) that is stratigraphically younger than the Ardleigh/ Oakley Gravel, the formation that includes the Cromerian deposits at Little Oakley, and stratigraphically older than the St Osyth/Holland Formation, which is correlated with the Anglian Stage glacial (Bridgland, 1988a; Bridgland *et al.,* 1988; (Figure 5.3); see also Little Oakley, and St Osyth and Holland-on-Sea). This makes the Wivenhoe deposits strong candidates for correlation with 'late Cromerian' sites recognized elsewhere in Britain and in north-west Europe. There is controversy at present over whether such sites represent the latter part of the Cromerian Stage (*sensu* West Runton) or an additional temperate episode between the type Cromerian interglacial and the Anglian glacial (see Chapter 1). Further research is required, however, to establish the age of the Wivenhoe deposits satisfactorily.

Description

Peaty deposits containing beetles were first reported from the Wivenhoe pit by McKeown and Samuel (1985), who provided a photographic record of a section showing organic sediments above gravel. These authors suggested that the peaty deposits were of Cromerian age, but cited no supporting evidence. Later investigations at the present GCR site revealed that deposits rich in plant material occur near the top of the Wivenhoe Gravel in a restricted area around [TM 050 236] (Bridgland *et al.,* 1988). The GCR section at Wivenhoe reveals the following sequence (Figure 5.13):

	Thickness
4. Silty clay, locally ?organic, cryoturbated	*c.* 1.5 m
3. Gravel and sand, horizontally bedded (Wivenhoe Upper Gravel)	1.5 m
2. Organic silty clay with scattered pebbles and plant remains, brecciated	*c.* 1 m

1. Medium–coarse sandy gravel interbedded with sand	(Wivenhoe Lower Gravel)	*c.* 5 m

The sequence is disrupted by frost cracks and ice-wedge pseudomorphs. Most of these appear to emanate from various levels within the upper gravel (member 3), but there are clearly some that formed in the sediments below prior to the deposition of this member (Figure 5.13). These features indicate that the upper gravel was laid down during a periglacial episode that followed the temperate period represented by the organic clay (member 2). Analysis of the clast content of the gravels below and above the organic clay has indicated that they have close similarities and that both are typical of the Low-level Kesgrave Subgroup (Bridgland, 1988a; Bridgland *et al.,* 1988; (Table 5.2)).

The organic silty clay contains pollen, plant macrofossils and insect remains. A pollen sequence has been determined (Gibbard, in Bridgland *et al.,* 1988), its arboreal component dominated by birch, pine, spruce and alder, with smaller quantities of, for example, silver fir, elm, oak, hornbeam, hazel and willow. A 500 gm sample from this unit has yielded a limited flora, comprising fruits of *Schoenoplectus lacustris* (L.) Palla, trigonal nutlets of *Carex* spp. and seeds of *Menyanthus trifoliata* L. (M.H. Field, pers. comm.). Two flint flakes, evidently formed by percussion, were recovered from the organic silty clay (Figure 5.13). Their interpretation as Palaeolithic artefacts, claimed by Bridgland *et al.* (1988), remains equivocal (see below).

Thin, involuted lenses of dark grey, possibly organic clay occur at higher levels in the sequence, within the cryoturbated upper part of the upper gravel (Figure 5.13). No pollen or other fossil material has been recovered from these levels (P.L. Gibbard, pers. comm.), which may represent reworking of organic material from the underlying silty clay.

Interpretation

This site is an important source of evidence for the reconstruction of Thames drainage evolution in the early Middle Pleistocene, shortly before the diversion of the river during the Anglian Stage. Prior to the discovery of various pre-Anglian interglacial sites within the Low-level Kesgrave Subgroup deposits of Essex (Bridgland *et al.,* 1988; see above, Ardleigh and Little Oakley), little was known about this time period. It had been widely accepted that all of the Kesgrave Sands and Gravels were aggraded during the Beestonian Stage (Rose *et al.,* 1976; Rose and Allen, 1977), but later studies revealed that a series of distinct terrace formations is represented and that deposition of these early Thames gravels spanned a large proportion of Pleistocene time (Rose, 1983a; Kemp, 1985a; Rose *et al.,* 1985b; see above, Introduction to Part 1).

The temperate-climate Valley Farm Soil and the (superimposed) periglacial Barham Soil were both identified at Wivenhoe by Rose *et al.* (1976), although the stratigraphical control of overlying Anglian glacial sediments is lacking at this site, which lies outside the maximum ice limit ((Figure 5.4)F). Kemp (1985a) observed that the Soil Survey of England and Wales had mapped a 'stagnogleyic palaeo-argillic brown earth' soil (their Tenciring Association) on undissected remnants of the Waldringfield, Ardleigh/Oakley and Wivenhoe/Cooks Green Gravels, the oldest three of the four Low-level Kesgrave Subgroup formations. Kemp considered this soil, which is restricted to the unglaciated area of north-east Essex, to contain relict features of the Valley Farm Soil. The temperate palaeosol is not, however, present in the GCR section, although the cryoturbation structures at the top of the sequence there may indicate the presence of the early Anglian Barham Soil.

The stratigraphical position of the Wivenhoe Formation in relation to other parts of the Low-level Kesgrave Subgroup puts considerable constraint on its relative age. It is later than the Ardleigh/Oakley Formation, which incorporates the Ardleigh and Little Oakley interglacial sediments. The Little Oakley channel deposits in particular, if correctly ascribed to the Thames, suggest that the river flowed at the level of the Ardleigh/Oakley Gravel until late in 'Cromerian Complex' times (see above, Little Oakley). The terrace formation immediately (altitudinally) below the Wivenhoe Gravel, the St Osyth/Holland Formation, has been attributed to the Anglian Stage on the basis of its apparent correlation with the diversion of the Thames (Bridgland, 1988a; see above, Introduction to Part 1 and below, St Osyth and Holland-on-Sea). This means that the Wivenhoe Formation must have accumulated during the interval between the Little Oakley interglacial and the down-cutting phase that preceded the deposition of the Lower St Osyth and Lower Holland Gravels. If the organic silty clay and the upper gravel at the GCR site (members 2 and 3) were laid down by the Thames, the former must represent a pre-Anglian temperate episode that post-dates the deposition of the Little Oaldey interglacial deposits (Bridgland *et al.,* 1988).

The palynology of the Wivenhoe organic sediments is not stratigraphically diagnostic. It merely provides a record of boreal forest vegetation of a type found in many interglacial and interstadial sequences (P.L. Gibbard, pers. comm.). The plant macrofossils are equally undiagnostic. They indicate the presence of a marshy area adjacent to a water body, but the three species listed above occur in cold- and warm-climate sediments throughout the British Pleistocene (M.H. Field, pers. comm.). It is hoped that further details of the palaeontology, when available, will provide information of stratigraphical significance.

The two flint flakes from the organic clay, if they represent a Palaeolithic occupation at Wivenhoe, may point to another aspect of the site's significance. The occurrence of palaeoliths in sediments of pre-Anglian age in Britain was not accepted until recently, but they have now been described from a number of sites of probable late 'Cromerian Complex' age (see, for example, Wymer, 1988; Chapter 1). These include cave deposits at Westbury-sub-Mendip, Somerset (Bishop, 1982), raised-beach deposits at Boxgrove, Sussex (Roberts, 1986), and lacustrine sediments rafted by Anglian Stage ice at High Lodge, Mildenhall, Suffolk (Wymer, 1988). The pre-Anglian age of all these sites is based on their mammalian faunas; all have the rhinoceros *Dicerorhinus etruscus,* which is unknown in Hoxnian and later sediments. The sites at Westbury and Boxgrove have also yielded the stratigraphically significant water vole *Arvicola cantiana,* which replaced the species *Mimomys savini* after Cromerian biozone CrIII, as represented at West Runton and Sugworth. *Arvicola cantiana* is claimed to occur in sediments attributed to the Cromer Forest Bed at Ostend, Norfolk, in pollen biozone CrIV (Stuart, 1982a, 1988). As has been noted in Chapter 1, there is considerable controversy, both in Britain and on the continent, about whether the evolutionary change between these vole species occurred within a single temperate episode or whether an additional temperate interval is represented that was both post-Cromerian (*sensu* West Runton) and pre-Anglian. It is worth noting that there is no convincing record of Palaeolithic artefacts from the Cromer Forest Bed (Wymer, 1988) or from any deposit with *Mimomys savini,* whereas Boxgrove, High Lodge and Westbury all yield palaeoliths (Wymer, 1988).

Deposits attributable to this 'late Cromerian' interval (characterized by A. *cantiana*) have yet to be identified in association with the Thames sequence. They would be anticipated in a stratigraphical position within the terrace sequence between Cromerian *sensu lato* sites that have *Mimomys savini,* such as Little Oakley, and the Anglian Stage St Osyth/Holland Formation. As the Wivenhoe Formation occupies exactly this position, the Wivenhoe organic deposit is a prime candidate for the first record of the Westbury temperate interval in the Thames system.

However, the evidence for assigning the Wivenhoe organic deposit to this interval is at present equivocal. In the absence of definitive palaeontological evidence, the interpretation of the site hinges on the stratigraphical relations of the various Low-level Kesgrave Subgroup formations. Another problem with this correlation is that it relies on the organic clay and the Wivenhoe Upper Gravel being products of the Thames and not of a tributary river. The clast composition of the Wivenhoe Upper Gravel is indistinguishable from the Wivenhoe Lower Gravel and from other Kesgrave Group deposits in the area (Table 5.2), providing some evidence for a Thames origin. It is possible, however, that a tributary stream with a localized catchment might have produced a gravel of identical composition to the various early Thames deposits. Such a river could have laid down the organic deposits and the upper gravel at any time after the deposition of the Wivenhoe Lower Gravel. Thus a pre-Anglian age is only indicated for the organic sediments if the Wivenhoe Upper Gravel is correctly interpreted as part of the Kesgrave Group.

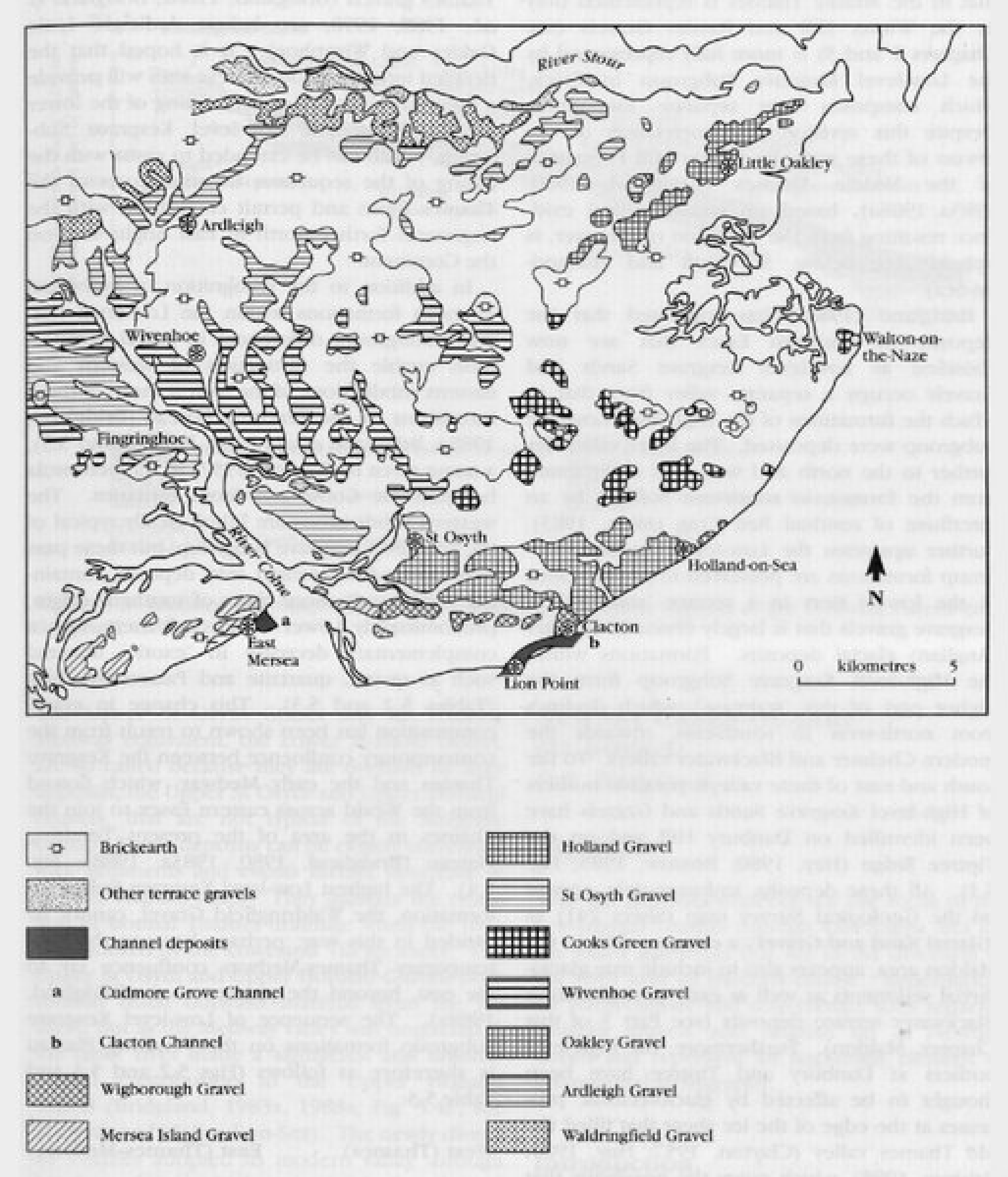
A hypothetical post-Anglian tributary stream would have to have been confined to the western part of the Tendring Plateau, since Medway-and Red Crag-derived material is present in the gravels to the north-east (see above, Ardleigh and Little Oakley), but is not found in the Wivenhoe Upper Gravel. There is also no indication of Anglian glacial erratics in the Wivenhoe Upper Gravel, and so the hypothetical post-Anglian river could not have had a catchment extending to the glacial limit. Given the sparse but widespread occurrence of clast types foreign to the Kesgrave Group in the area, it seems unlikely that a post-Anglian stream of any size could have produced a deposit with the composition of the Wivenhoe Upper Gravel. A pre-Anglian Thames origin for this unit and the underlying biogenic sediments seems, therefore, to be indicated.

Supporting evidence for the occurrence of a further temperate interval between the Little Oaldey interglacial and the Anglian Stage is provided by the identification of relict elements of the Valley Farm Soil in the upper levels of the Wivenhoe/Cooks Green Formation (Rose *et al.,* 1976; Kemp, 1985a). In the unglaciated area of north-east Essex, the soil is only present in relict form and there is no upper stratigraphical control on its age. The occurrence of rubified soils similar to the pre-Anglian Valley Farm Soil on post-Anglian deposits in the Chelmsford area (Rose *et al.,* 1978; Sturdy *et al.,* 1978), suggests that caution should be exercised in identifying the Valley Farm Soil outside the Lowestoft Till limit. It may prove possible, however, to relate the palaeosol exposed in other parts of the Wivenhoe workings, recorded by Rose *et al.* (1976), to the stratigraphical level of the organic clay member; an assessment of this relationship is awaited.

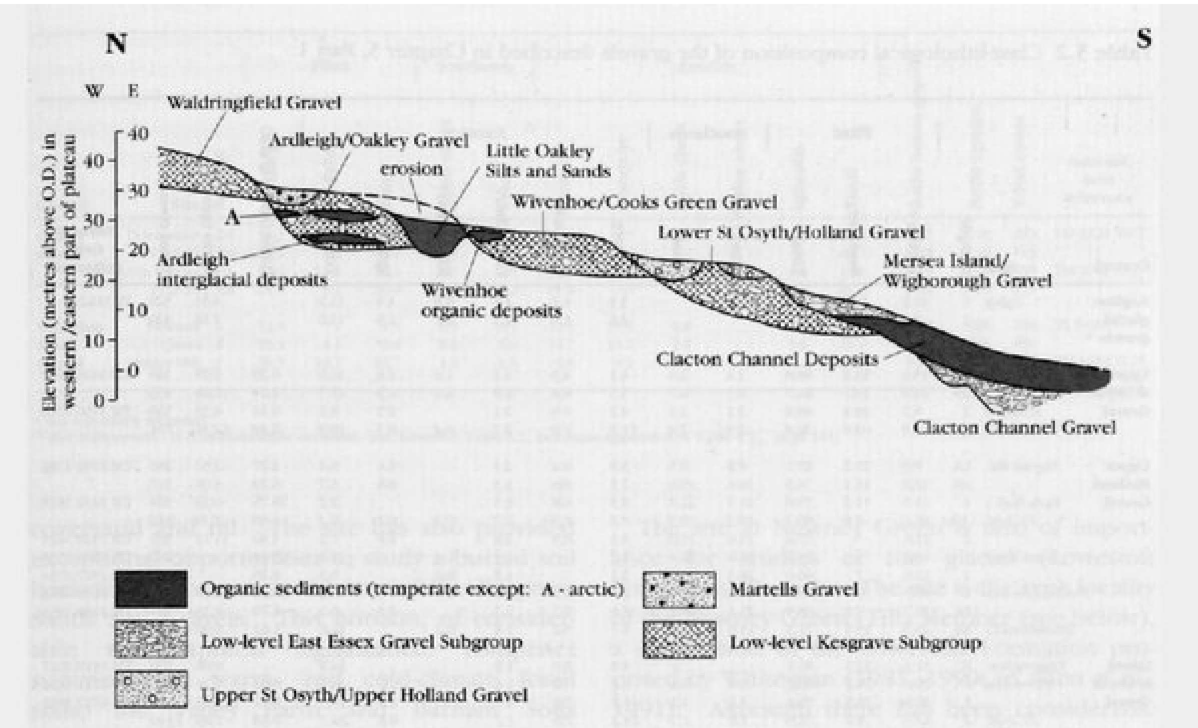
Conclusions

The GCR site at Wivenhoe provides sections in sediments formed by the early River Thames at a time when it flowed north-eastwards across East Anglia, before its diversion to its modern course. This is the only locality discovered to date in the Thames system that is likely to represent the temperate interval that immediately preceded the (Anglian) glaciation (this glaciation brought about the river's diversion about 450,000 years ago). Much work is required before this interval, recognized in recent years elsewhere in Britain but as yet undefined, can be fully evaluated. Its status as a full interglacial has yet to be firmly established; it could be that an interstadial (a short-lived temperate-climate event during a predominantly cold period) is represented and it remains possible that the sediments date from the latter part of the type-Cromerian interglacial, as defined at Cromer. More work is required on the fossiliferous sediments and the stratigraphy at Wivenhoe to confirm or deny correlation with this period.

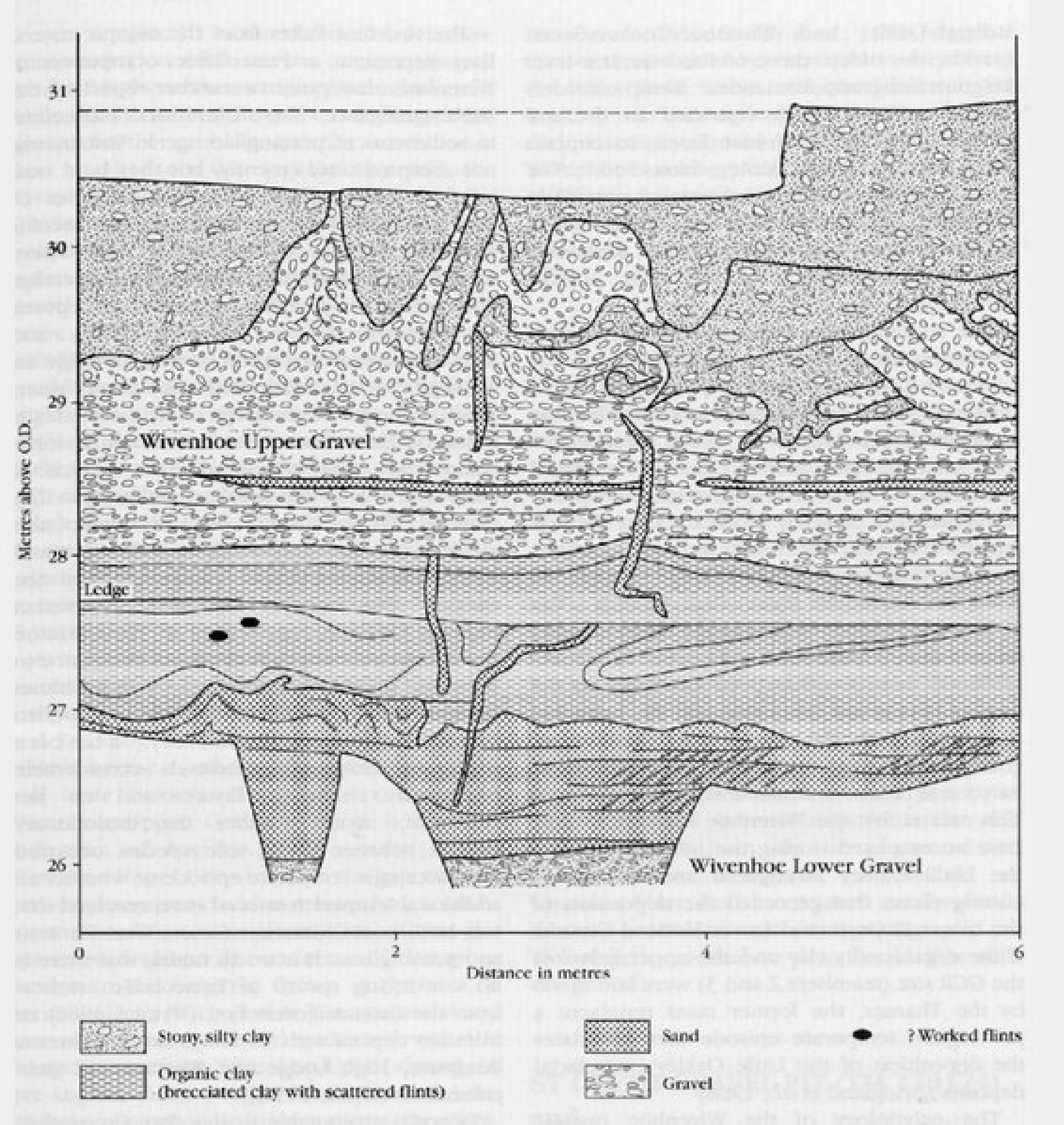
References



(Figure 5.2) Pleistocene gravels of the Tendring Plateau (after Bridgland, 1988a).



(Figure 5.3) Idealized N—S transverse section through the Pleistocene deposits of the Tendring Plateau (after Bridgland, 1988a).



(Figure 5.13) Section at Wivenhoe, showing the organic clay (modified from Bridgland et al., 1988)

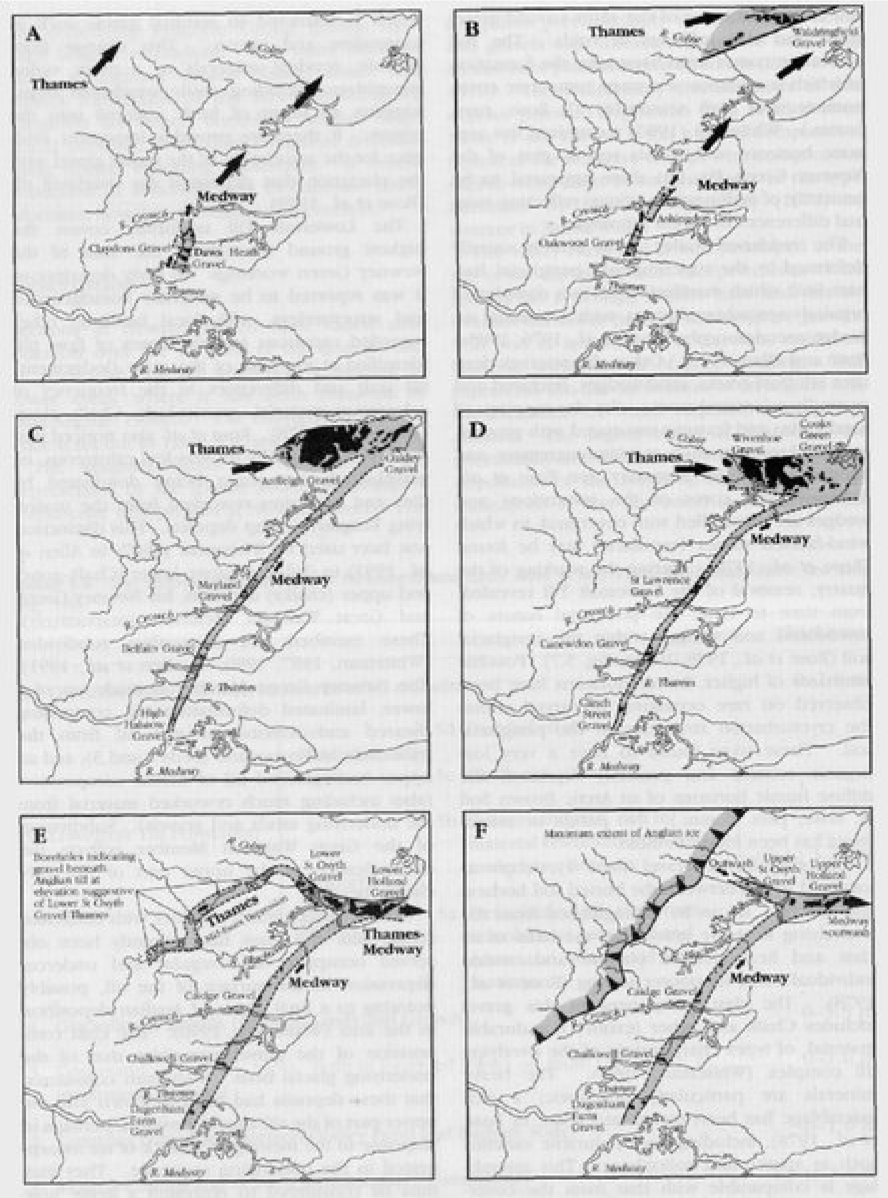
Gravel	Site	Sample	Flint: Tertiary	Flint: Nodular	Flint: Total	Southern: Greensand chert	Southern: Total	Quartz	Quartzite	Carb. chert	Rhax chert	Igneous	Exotics: Total	Ratio (others: q+qzt)	Ratio (q:qzt)	Total count	National Grid Reference
Anglian glacial gravels**	Ugley	1	61.9	25.7	87.9			3.5	0.8	1.5	0.4	1.9	11.9		4.55	520	TL 516278
		2	3.6	37.6	87.1			2.6	1.7	2.1	1.7	1.9	12.6		1.56	420	
Upper St Osyth Gravel	Fingringhoe	1A	15.4	15.0	80.8	2.4	2.4	4.1	4.5	4.1	1.4	0.8	16.8	0.29	0.95	509	TM 0419 2017
		1B	15.9	15.7	80.7	3.7	3.7	5.7	6.0	0.9	0.9	0.9	17.7	0.05	0.84	455	
	St Osyth	2	9.7	19.1	89.8	2.1	2.1	6.2	0.9	2.1		0.2	9.3	0.41	4.35	530	TM 1195 1704
	11.2-16	*2(b)*	*16.9*	*9.4*	*78.4*	*2.4*	*2.4*	*11.9*	*3.0*	*2.7*	*0.4*	*0.3*	*18.8*	*0.18*	*12.50*	*704*	
Upper Holland Gravel	Bypass Rd.	1A	9.9	21.5	82.1	8.8	9.5	5.8	0.4	2.5		0.4	8.4	2.27	2.50	265	TM 1161 1705
		1B	12.6	16.1	74.8	18.6	18.6	2.5	0.6	1.5		0.6	5.7	6.20	4.00	517	
	Earls Hall 1	1	15.5	51.5	79.8	21.7	21.7	3.5	0.8	0.5			2.2	19.75	6.33	564	TM 1632 1625
	11.2-16	*2(b)*	*26.0*	*8.8*	*80.2*	*10.2*	*10.5*	*4.2*	*1.5*	*2.7*	*0.3*	*0.1*	*9.1*	*1.60*	*2.79*	*952*	
		2	13.6	*	77.6	15.0	15.5	3.6	0.3	7.8		0.6	7.2	4.50	11.11	561	TM 1639 1625
	Burrs Road	1	10.8	*	64.8	30.0	30.4	2.7		1.4	1.4		3.8	45.00		207	TM 1920 1759
		2	11.6	*	66.0	29.4	29.8	3.3		1.5	0.6		5.5	9.20		320	TM 1927 1754
	Holland-on-Sea	1	15.5	8.7	70.7	26.5	26.7	2.2	0.2	1.0	0.5		4.6	18.35	11.11	413	TM 2108 1662
		2A	15.7	9.8	68.9	25.1	25.1	3.0	0.7	0.7		0.5	6.0	6.70	4.35	207	TM 2109 1663
	Gunnfleet(?)	2B	20.7	13.5	71.3	15.6	15.1	4.7	5.2	1.4	0.2		12.6	1.62	0.90	422	
Lower St Osyth Gravel	Fingringhoe	1C	31.1	12.5	85.1			6.8	8.0	1.0			15.9		0.80	376	TM 0419 2017
	Moverons	1	29.0	16.0	80.0	3.0	3.0	8.3	7.0	1.4		1.0	18.1	0.06	1.20	429	TM 0731 1918
		2	30.8	16.5	79.6	1.1	1.1	11.2	5.5	0.7		0.5	19.3	0.07	2.13	1021	TM 0712 1919
	11.2-16	*2*	*32.3*	*5.9*	*73.3*	*1.6*	*1.7*	*14.2*	*7.6*	*1.7*		*0.8*	*24.7*	*0.09*	*1.80*	*1340*	
		3	31.8	13.1	77.3	3.6	3.7	11.4	7.8	1.3		0.7	21.7	0.06	1.47	954	TM 0699 1825
	St Osyth	1A	35.4	*	77.1	3.5	3.5	11.1	7.7	3.8		0.2	22.4	0.05	1.45	559	TM 1161 1706
		1B	30.6	*	79.8	1.5	1.5	10.4	4.9	1.5		0.7	18.6	0.10	2.13	748	
	11.2-16	*1B*	*30.7*	*7.7*	*78.0*	*1.7*	*1.7*	*12.5*	*4.8*	*2.0*		*0.3*	*20.2*	*0.10*	*2.61*	*1129*	
Lower Holland Gravel	St Osyth	3	21.6	16.8	83.1	1.4	1.4	10.3	2.7	1.6		0.5	15.3	0.11	3.29	561	TM 1201 1703
		5	21.8	20.8	85.0	4.6	4.9	5.8	0.8	1.8		0.5	15.3	0.38	0.85	525	TM 1215 1665
		6	29.5	16.8	81.3	2.2	2.5	8.8	5.3	1.5			16.0	0.18	1.67	519	TM 1225 1688
	Bush Paddock	1	43.5	39.5	83.9	4.8	5.1	5.0	3.7	0.8		0.5	11.8	0.55	1.59	567	TM 1257 1611
	11.2-16	*1*	*40.0*	*5.7*	*75.8*	*15.5*	*15.6*	*9.2*	*2.4*	*0.8*	*0.1*	*0.2*	*15.8*	*0.79*	*3.87*	*1275*	
	Holland-on-Sea	2C	32.0	11.9	83.6	2.2	2.2	8.0	7.5	1.0		0.2	17.2	0.14	1.06	412	TM 2109 1663
		2D	26.7	13.8	80.5	1.8	1.8	9.2	5.6	1.1		0.3	16.5	0.12	1.64	375	
	Holland Haven	1A	21.9	*	81.0	2.1	2.9	7.3	3.7	1.6	0.3	0.3	13.1	0.26	1.96	382	TM 2208 1744
		1B	31.6	14.6	85.1	2.5	4.1	9.6	4.6	0.4			15.9	0.26	2.08	200	
		2	25.3	*	82.2	2.8	3.3	8.4	3.9	1.7	0.2	0.2	14.0	0.26	2.17	536	TM 2203 1743
	11.2-16	*2*	*31.9*	*7.2*	*78.8*	*1.2*	*1.2*	*12.4*	*2.2*	*1.4*	*0.2*	*0.9*	*18.0*	*0.06*	*5.64*	*939*	
	Clacton cliffs	4C	30.9	15.2	81.3	8.5	8.8	3.2	4.4	1.2	1.7		9.7	1.18	0.72	453	TM 1730 1430
		4D	38.7	12.6	81.5	5.3	5.5	6.4	2.8	2.0		0.5	12.9	0.41	2.27	357	
	11.2-16	*4D*	*29.9*	*6.6*	*78.7*	*10.2*	*10.8*	*5.5*	*3.0*	*1.2*	*0.4*		*10.8*	*1.15*	*1.52*	*804*	
Wivenhoe Gravel	Wivenhoe	1B	25.1	17.8	83.1	0.8	0.8	5.4	9.7	2.7		0.5	18.3	0.05	0.56	371	TM 0456 2330
	(Wiv.2 Gr.)	2A	36.1	14.7	74.5	0.4	0.7	12.4	5.5	1.4		0.6	20.7	0.05	1.31	293	TM 0495 2398
	Alresford	1	36.0	8.1	73.5	0.4	0.6	16.2	8.1	2.6		0.7	26.8	0.02	1.79	156	TM 0711 2192
	11.2-16	*1*	*32.2*	*4.7*	*66.3*	*1.4*	*1.4*	*17.7*	*10.0*	*2.3*		*2.1*	*32.4*	*0.05*	*1.67*	*726*	
		2	21.5	16.9	82.5	0.9	0.9	7.3	7.8	1.5		0.6	16.6	0.06	1.04	344	TM 0711 2192
Cooks Green Gravel	Cooks Grn	1A	21.3	*	85.8	3.2	3.2	7.2	3.5	1.0		0.5	13.6	0.34	2.04	325	TM 1800 1856
		1B	27.7	14.4	84.2	2.0	2.0	8.3	2.2	2.8			13.8	0.25	3.76	492	
	11.2-16	*1B*	*26.9*	*7.8*	*72.5*	*3.7*	*3.7*	*15.4*	*4.7*	*2.2*		*0.3*	*23.7*	*0.17*	*3.47*	*1205*	
		2	29.4	12.7	85.3	3.3	3.3	8.1	4.1	0.5		0.3	13.5	0.27	1.90	394	TM 1808 1840
	Gt Holland	1	25.5	19.5	86.3	3.7	3.7	8.4	6.0	0.7			16.0	0.12	1.41	459	TM 2112 1802
	11.2-16	*1*	*25.9*	*8.6*	*80.3*	*3.1*	*3.2*	*8.9*	*5.5*	*1.8*	*0.1*	*0.2*	*16.5*	*0.22*	*1.61*	*1203*	
Little Oakley Silts and Sands	L Oakley	4B	33.6	12.6	87.4	0.8	0.8	4.2	5.5	1.7			11.8	0.08	0.71	119	TM 2230 2932
	11.2-16	*4B*	*26.4*	*7.3*	*77.0*	*2.0*	*2.0*	*11.3*	*6.0*	*2.0*			*20.4*	*0.06*	*1.51*	*205*	
	4C	33.7	30.7	40.7	0.6	0.6	9.5	4.8	5.4			0.4	15.9	0.05	1.96	252	TM 2225 2931
	11.2-16	*4C*	*20.7*	*8.5*	*73.1*	*1.6*	*1.6*	*13.2*	*8.3*	*1.2*	*0.1*	*0.6*	*25.2*	*0.07*	*1.45*	*678*	
		4F	26.0	16.3	80.3	1.9	1.9	9.8	6.5	1.2			17.9	0.11	1.46	223	TM 2250 2946
	11.2-16	*4F*	*20.8*	*6.4*	*70.8*	*2.2*	*2.3*	*15.3*	*6.5*	*3.8*		*0.6*	*26.9*	*0.11*	*2.21*	*640*	
Martello Gravel	Ardleigh	5	20.5	14.1	76.5	1.6	1.6	10.4	8.2	1.4	0.2	0.8	21.9	0.08	1.20	512	TM 0515 2800
		8C	19.5	13.2	76.7	0.7	0.7	11.7	7.5	2.5	0.1	0.5	21.6	0.03	1.61	605	TM 0520 2807
	11.2-16	*8C*	*26.2*	*4.5*	*72.5*	*2.0*	*2.2*	*14.5*	*7.0*	*2.7*	*0.1*	*1.0*	*25.8*	*0.05*	*2.09*	*596*	
Ardleigh Gravel	Ardleigh	1	26.8	15.4	75.6	0.7	0.7	13.9	7.5	0.8		1.5	23.6	0.04	1.58	590	TM 0530 2862
	11.2-16	*1*	*27.1*	*7.7*	*72.1*	*1.2*	*1.7*	*16.4*	*7.3*	*2.2*		*0.2*	*25.9*	*0.07*	*2.13*	*2008*	
		2	23.7	10.2	80.0	1.5	1.5	9.5	5.8	2.0			17.7	0.10	1.72	815	TM 0535 2805
	11.2-16	*2*	*29.0*	*6.4*	*69.9*	*0.7*	*1.0*	*16.0*	*9.5*	*3.0*		*0.7*	*29.1*	*0.04*	*1.57*	*1215*	
		4B	29.3	13.0	75.4	1.5	1.5	9.8	9.5	1.1		1.1	23.0	0.07	1.06	467	TM 0520 2867
	Ardleigh L.O.(?)	6A	35.3	13.7	72.0	0.4	0.4	13.6	15.5	1.1		0.9	27.5	0.01	0.92	551	

Gravel	Site	Sample	Flint: Tertiary	Flint: Nodular	Flint: Total	Southern: Greensand chert	Southern: Total	Quartz	Quartzite	Carb. chert	Rhax chert	Igneous	Exotics: Total	Ratio (others: q+qzt)	Ratio (q:qzt)	Total count	National Grid Reference
Oakley Gravel	Dovercourt	DA	30.5	12.1	79.1	2.1	3.4	9.8	4.7	1.6		1.1	18.5	0.11	2.08	379	TM 2328 3127
	11.2-15	*DA*	*25.3*	*6.3*	*75.0*	*4.7*	*4.9*	*12.7*	*5.5*	*1.7*			*20.1*	*0.20*	*2.31*	*783*	
	Little Oakley	KA	30.3	15.5	80.2	2.6	2.6	8.8	7.2	0.6	0.3	0.3	17.4	0.15	1.19	653	TM 2191 2947
	11.2-15	*KA*	*25.7*	*9.1*	*70.4*	*2.1*	*2.2*	*13.9*	*7.0*	*1.9*	*0.2*	*0.3*	*21.3*	*0.12*	*1.79*	*677*	
Waldringfield Gravel	Newney	1	52.9	*	72.5	0.5	0.5	10.5	11.7	0.8		1.2	25.5	0.02	0.90	599	TL 645064
	Green	2	55.3	4.1	70.6	0.6	0.6	14.7	10.2	0.8		0.6	26.3	0.02	1.45	490	
	Motley Hill	1	26.3	13.7	82.7	1.6	1.6	9.8	9.6	1.6			15.6	0.09	1.06	305	TM 1262 5125

* Not separately recorded

** (for comparison. N.B. non-durables excluded - see, however Table 3.1, and notes appended to Table 4.2., page 181)

(Table 5.2) Clast-lithological composition of the gravels described in Chapter 5, Part 1.



(Figure 5.4) Palaeodrainage of eastern Essex up to the Anglian glaciation (after Bridgland, 1988a): (A) Palaeodrainage at the time of deposition by the Medway of the Claydons and Daws Heath Gravels, part of the Rayleigh Hills gravels. The Thames and Medway are thought to have had separate routes to the North Sea at this time. (B) Palaeodrainage at the time of deposition by the Medway of the Oakwood and Ashingdon Gravels. The Waldringfield Gravel, which might be a correlative of the Ashingdon Gravel, is also shown. It is believed that the Thames and Medway joined during Waldringfield Gravel times, but this confluence is believed to have been situated to the east of the present coastline. (C) Palaeodrainage at the time of deposition by the Thames of the Ardleigh Gravel. (D) Palaeodrainage at the time of deposition by the Thames of the Wivenhoe Gravel. (E) Palaeodrainage during the early Anglian Stage, prior to the inundation of the Thames valley by the Lowestoft Till ice sheet. (F) Palaeodrainage during the Anglian glaciation, prior to the diversion of the Thames but after its valley became blocked by ice. The highly distinctive Upper St Osyth and Upper Holland Gravels were laid down at this time.