Moor Mill Quarry

[TL 145 027]

D.R. Bridgland

Highlights

This is a classic locality that shows pre-diversion Thames deposits overlain by laminated, pro-glacial lake clays, Anglian till and a later suite of gravels deposited by the early River Colne, the sequence as a whole illustrating the glacial diversion of the Thames from this area.

Introduction

The sequence at Moor Mill Quarry, which is situated in the western part of the Vale of St Albans, is of major importance for demonstrating the glacial diversion of the Thames. The sequence includes glaciolacustrine sediments that are believed to have been deposited in a lake formed by the ponding of the Thames by Anglian Stage ice. Till overlies the lacustrine beds, indicating that the ice subsequently overrode the lake. Gravels below the lake beds are attributed to the Thames, whereas those above the till were deposited by the newly formed River Colne. The replacement of the Thames by the Colne in the western part of the Vale of St Albans can thus be shown to have occurred in the interval represented at Moor Mill by glacial deposits.

The overflow from the Moor Mill lake is considered to have brought about the diversion of the Thames into its modern valley through London (Gibbard, 1977, 1979), although overflow from an earlier lake in the Hertford area may have resulted in the diversion of the river into southern Essex via the Lower Lea (Cheshire, 1981, 1986a; see above, Westmill).

Description

The first description of exposures at Moor Mill was by Evans (1954), although Prestwich (1858b) had described a similar sequence (excluding the lacustrine sediments) at Bricket Wood, about 2 km to the south-west. The Moor Mill site was described in detail by Gibbard (1974, 1977, 1978d). The nomenclature applied to some elements of the sequence has been modified as a result of later work in the Vale of St Albans by Cheshire (1986a). The sediments exposed at Moor Mill are as follows:

	Thickness
4. Sand and gravel, (Smug Oak cross-bedded Gravel)	5 m
3. Chalky till, blue- (Ware Till) grey	6 m
2. Laminated clay (Moor Mill Laminated Clay)	2.6 m
1. Sand and gravel, (Westmill cross-bedded Lower Gravel)	6.5 m
Chalk	

Evans's (1954) sections, to the north and west of the present GCR site, differed from the above only in that he recorded slightly decreased thicknesses for all the units. He suggested that the laminated sediments were of glaciolacustrine origin, the banding being of seasonal origin and comparable to Swedish varves. Gibbard's (1974, 1977) descriptions, which are the basis of the sequence reproduced above, fully confirmed the stratigraphy reported by Evans.

The Westmill Lower Gravel (unit 1) rests on an uneven surface of brecciated Chalk. It comprises laterally persistent, massive, coarse gravels and current-bedded coarse sands and fine gravels, as well as localized silt. Gibbard (1974) reported an ice-wedge cast from the lower part of these deposits, indicating periglacial conditions during deposition (see (Figure 3.11)). According to Gibbard, imbrication of the lowermost, coarsest gravel and cross-stratification in the sands both indicate a north-eastward palaeocurrent direction. Clast-lithological analysis revealed a flint-dominated composition

(85–90%) with quartz and quartzite (9–12%), small amounts of Lower Greensand chert and various far-travelled minor components (Gibbard, 1974, 1977; (Table 3.2)). This is similar to the composition that characterizes the various terrace gravels of the Middle Thames, particularly those originally mapped as 'Glacial' (see above, Introduction to Part 2).

Moor Mill Quarry is the type locality for the Moor Mill Laminated Clay (unit 2). Evans (1954) noted that, in the sections he studied, the lower part of this deposit was of a brownish hue and that it resembled Reading Beds material, whereas the upper part comprised alternations of pale silt and dark grey clay, similar to the matrix of the local till. Only the upper part of the member appears to have been recorded in more recent exposures, which show laminated deposits directly overlying the Westmill Lower Gravel (Gibbard, 1974, 1978d; Cheshire and Gibbard, 1983). The upper part of the unit has been somewhat deformed, presumably when overriden by the ice that deposited the overlying till (Gibbard, 1974, 1978d). Trace fossils have been recognized on bedding planes within the laminated sediments (Gibbard and Stuart, 1974).

The Moor Mill Laminated Clay resembles a classic glacial lake deposit (Figure 3.12). A minimum total of 342 laminar pairs was counted from a vertical section through this deposit at the nearby Harper Lane Quarry [TL 164 019]. If these laminar pairs can be interpreted as annual varves, their number points to the existence of a lake in the area for a period of at least that many years (Cheshire and Gibbard, 1983). Only 246 laminar couplets have been recorded at Moor Mill (Gibbard, 1974, 1978d).

The overlying Ware Till (unit 3) consists of a grey silty clay, passing upwards into a massive chalky till. Gibbard suggested that the lower part of the till was deposited from floating ice, this giving rise to its partial stratification. The superposition of this till over the lacustrine laminated clays indicates that the ice sheet finally advanced and overrode the proglacial lake. Fabric analysis of the till suggests that ice movement was from the north-east (Gibbard, 1974, 1977, 1978d).

The Smug Oak Gravel (unit 4), which also has its type site at Moor Mill, has an irregular base, filling channels in the upper surface of the underlying till. The gravel is weakly cross-bedded and somewhat disturbed. Palaeocurrent measurements, from imbrication and foreset orientation, indicate flow to the south-west (Gibbard, 1974, 1978d). Stone counts show, in comparison with the Westmill Lower Gravel, a larger proportion of quartz and quartzite, a higher chalk content and the disappearance of Greensand chert, confirming a significant change in provenance (Gibbard, 1974, 1978d; (Table 3.2)).

Interpretation

The occurrence of glaciolacustrine deposits in the Vale of St Albans has been known since the 1920s. Sherlock (1924; Sherlock and Pocock, 1924) described possible lacustrine beds in the Watford area and suggested that these were related to the glacial ponding of the early Thames. Evans (1954) and Clayton and Brown (1958) provided further records of such lacustrine beds. Clayton and Brown described deposits of this type over a wider area, including the eastern Vale of St Albans and the 'Finchley Depression'. They postulated that an ice advance from the north-east had formed a large ice-dammed lake (Lake Hertford) in this area.

The involvement of the 'Chalky Boulder Clay' (Anglian) glaciation in the diversion of the Thames from the Vale of St Albans was not universally accepted, however. Wooldridge (1938, 1957, 1960) and Wooldridge and Linton (1939, 1955) believed that the river had abandoned the Vale of St Albans for an intermediate route through Finchley long before this glaciation, perhaps in response to an earlier invasion by ice ((Figure 3.4); see above, Introduction). Zeuner (1945, 1959) preferred to attribute the diversion of the Thames to river capture. Rose et al(1976) considered that the Thames had ceased to flow northwards to East Anglia by Cromerian times, since they recognized a Cromerian palaeosol developed in the upper surface of early Thames (Kesgrave Group) gravels in Suffolk (see Chapter 5, Part 1). Later work has, however, identified lower-level pre-diversion Thames gravels in north-east Essex that lack this fossil soil and are attributed to the Anglian Stage (Bridgland, 1988a), thus reconciling the disappearance of the Thames in Suffolk prior to the Anglian with the theory of Anglian glacial diversion from the Vale of St Albans.

The first systematic work in the Vale of St Albans was by Gibbard (1974, 1977, 1978a), who recognized the deposits of two separate proglacial lakes, both of Anglian age. One of these, his Watton Road lake (see above, Westmill), was in the

Ware area ((Figure 3.10)B), where its deposits were previously recognized by Clayton and Brown (1958). The second lake was at the western end of the Vale of St Albans, around Bricket Wood ((Figure 3.10)C). Gibbard believed that these lakes were ponded by separate ice advances, but Cheshire (1983a, 1986a) demonstrated that both formed (albeit at different times) as a result of the first ice advance into the area, that which deposited the Ware Till (see above, Westmill). Lacustrine beds beneath the Ware Till at Moor Mill Quarry (Gibbard, 1974, 1978d) represent the second, larger lake (Figure 3.10)C. This lake was formed after the ice advanced upstream in the pre-diversion Thames valley, beyond the position of the Watton Road lake.

Gibbard (1974, 1977, 1978a) interpreted the lower gravel at Moor Mill as an upstream continuation of the Westmill Gravel of the Hertford area, on the basis of its composition, stratigraphical position and palaeocurrents. He attributed this deposit to the Thames. In its type area, the Westmill Gravel was divided by Gibbard into upper and lower members, separated by the Ware Till (see above, Westmill). On the grounds of distribution, composition and elevation, he correlated the Westmill Gravel with the Winter Hill Gravel of the Middle Thames, tracing a single formation, the Winter Hill/ Westmill Gravel, from the Reading area into the Vale of St Albans.

Hare (1947) had shown that the Winter Hill Terrace surface has a very low gradient as it approaches the Thames-Colne confluence. He attributed this to the effects of the aggradation of outwash from the 'Great Eastern Glaciation' (now assigned to the Anglian Stage) in this area, recognizing (following Wooldridge (1938)) that the Winter Hill Thames and the Vale of St Albans glaciation were broadly coeval. Gibbard found that the low-gradient part of the Winter Hill Terrace profile, around Stoke Common, Buckinghamshire [SU 983 852], is underlain by gravel and sand with very large-scale cross-stratification, suggestive of a deltaic origin. He interpreted these deposits as a localized Winter Hill Upper Gravel Member, formed as a delta built out into the proglacial (Moor Mill) lake at the western end of the Vale of St Albans. This member is therefore of equivalent age to the Moor Mill Laminated Clay, which was deposited in the same lake, formed by the ponding of the Thames in front of the advancing Ware Till ice (Cheshire, 1986a; (Figure 3.10)C). Although not disputing the deltaic origin of the Winter Hill Upper Gravel, Cheshire (1986a) pointed out that the flattening of the terrace gradient immediately upstream of the Vale of St Albans may be partly the result of isostatic uplift that followed the disappearance of the Anglian ice sheets from the eastern part of the area.

The till at Moor Mill was correlated by Gibbard (1974, 1977, 1978a, 1978b) with his 'Eastend Green Till' of the Hertford area, which he attributed to the second of two Anglian glacial advances into the Vale of St Albans. According to Gibbard, this same till capped the sequence at Westmill and thus post-dated both the Westmill Upper and Lower Gravels (see above, Westmill). However, subsequent detailed reappraisal of the tills of the Vale of St Albans by Cheshire (1983a, 1986a) has shown that the till at Moor Mill can be correlated with the lower till at Westmill, the Ware Till. The Westmill Upper Gravel, which overlies this till at Westmill, is therefore later than any part of the lower gravel at Moor Mill, which must as a result be redefined as Westmill Lower Gravel (Cheshire, 1983a, 1986a). This modification of the sequence of events established by Gibbard (1974, 1977) in no way undermines the importance of the Moor Mill sequence in illustrating the diversion of the Thames from the Vale of St Albans, although the river may have been initially diverted from its old route east of Hertford by the overflow of the earlier Watton Road lake, flowing for a brief interval by way of the Vale of St Albans and the Lower Lea valley (Cheshire, 1983c, 1986a; see above, Westmill).

The palaeocurrent data from the Smug Oak Gravel, which caps the Moor Mill sequence, contrasts with that from the Westmill Lower Gravel and indicates that the river responsible for its deposition drained in the opposite direction to the Thames. Gibbard (1977) traced this gravel to Uxbridge, where it forms the Black Park Terrace of the Colne (Hare, 1947). He therefore interpreted the Smug Oak Gravel as an early Colne deposit, equivalent in age to the Black Park Gravel, which has been shown to be the earliest terrace formation represented in the modern Thames valley through London (Wooldridge and Linton, 1955; Gibbard, 1979; Chapter 1). Gibbard (1977) considered the Smug Oak Gravel to be of late Anglian age, deposited by meltwater from his 'Eastend Green Till' ice sheet. Cheshire (1986a) correlated the Smug Oak Gravel with the Westmill Upper Gravel of the Lea basin, which, he believed, was also fed by outwash from Anglian ice sheets as they fluctuated around the eastern end of the Vale of St Albans (see above, Westmill).

The change, in the western part of the Vale of St Albans, from a north-eastward to a southwestward flowing river is clearly seen from the sequence at Moor Mill Quarry to be associated with the advance of the Ware Till ice into the area. Since it could not have coexisted in the vale with the south-westward draining Colne, as represented by the Smug Oak

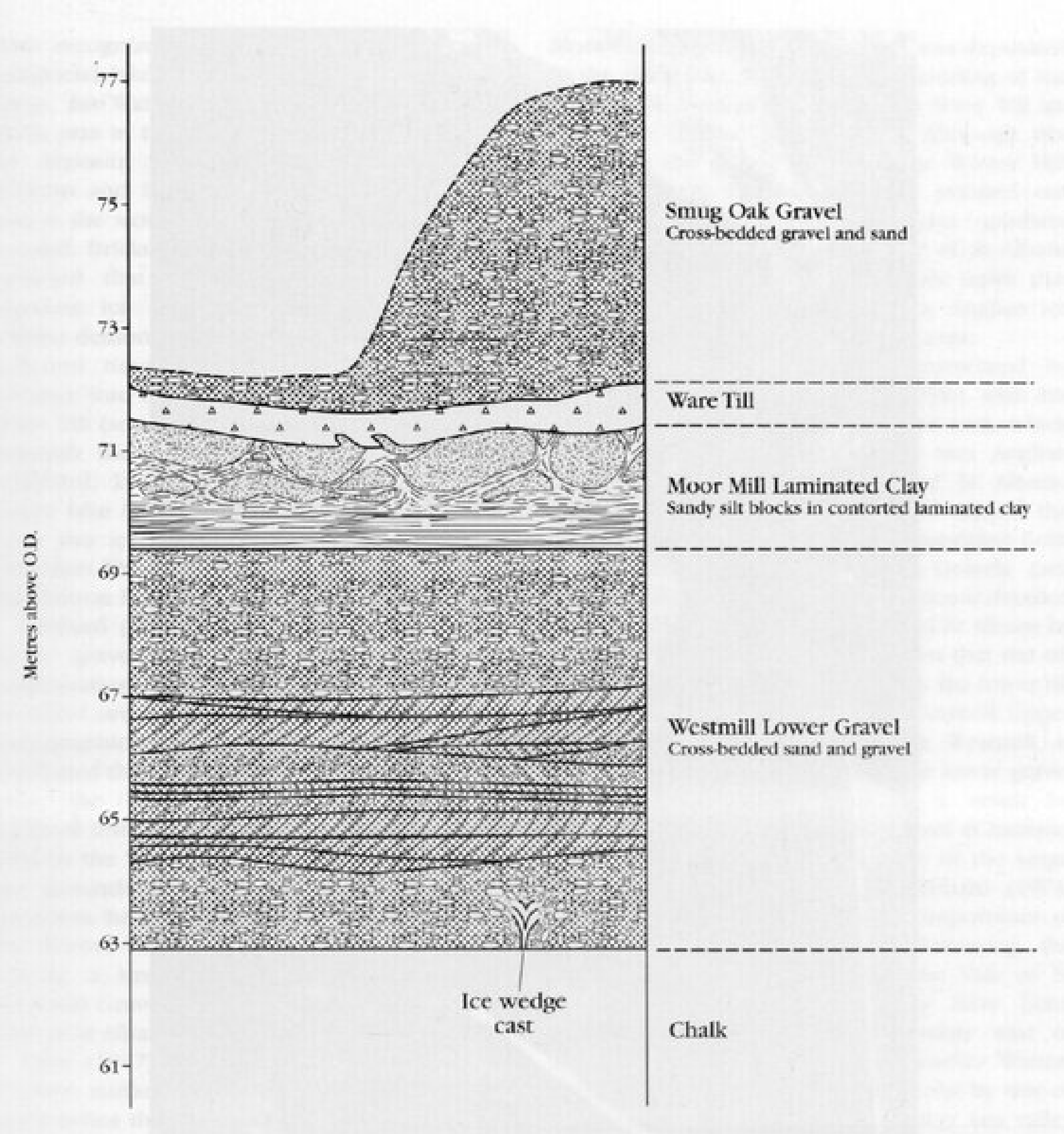
Gravel, the diversion of the Thames must have taken place prior to the deposition of this gravel, during the interval represented at Moor Mill by the laminated clay and till. This strongly supports the hypothesis that the Thames was glacially diverted from the Vale of St Albans, presumably as a result of the blocking of its valley by the Ware Till ice sheet. This initially caused the ponding of a proglacial lake in the Moor Mill area, which was eventually overriden by a further advance of the ice, its waters escaping southwards through the Chertsey area into the modern valley (Gibbard, 1977). The valley through London is considered to have already been established, in pre-Anglian times, as a tributary of the River Medway, which flowed northwards across eastern Essex (Bridgland, 1980, 1988a).

The diversion of the Thames, as demonstrated by the sequence at Moor Mill, provides an important stratigraphical marker that can be used for correlation between parts of the Thames basin and particularly with the sequence downstream in Essex, where the diversion resulted in the Thames adopting the pre-existing valley of the Medway (Bridgland, 1980, 1983a, 1983b, 1988a; see Chapter 5, Part 2; St Osyth and Holland-on-Sea). This correlation provides a basis for wider comparison of the sequences in the Middle Thames/Vale of St Albans and East Anglia.

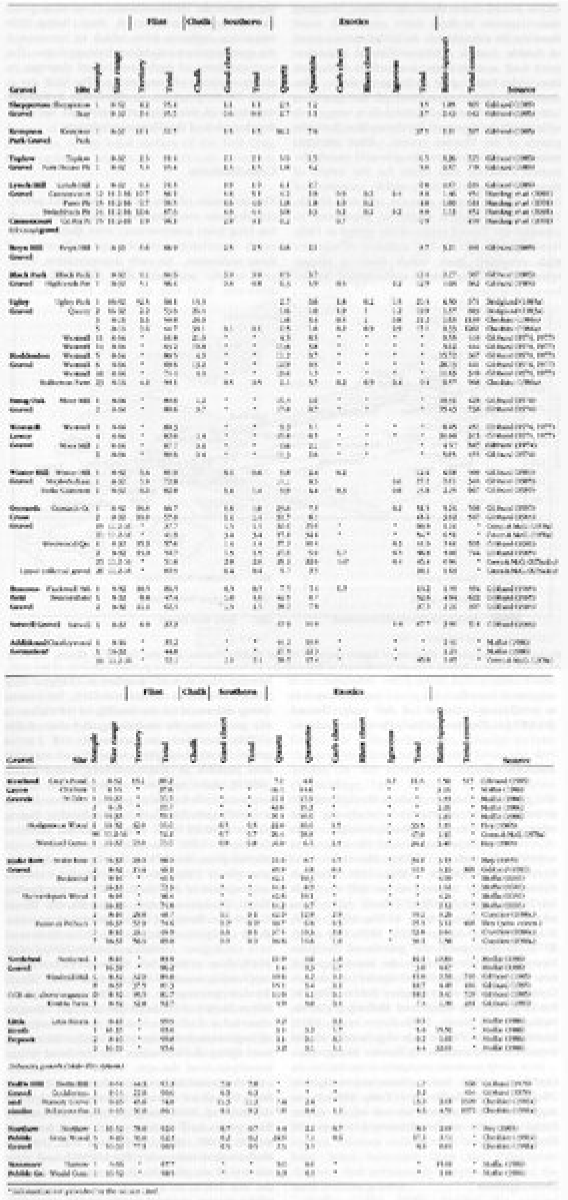
Conclusions

The sequence at Moor Mill Quarry is important for reconstructing Quaternary Ice Age events, at around 450,000 years ago, that had a major influence on the evolution of the Thames drainage system. It illustrates that the Thames formerly flowed through this area, that it was ponded by an ice sheet and that this resulted in a reversal of the local drainage, with the replacement of the Thames by the southwestward-flowing River Colne. The sequence begins with a Thames gravel, with evidence from bedding structures confirming deposition by this north-eastward-flowing river. This gravel is overlain by a distinctive laminated clay deposit, typical of sedimentation in a glacial lake. This lake is believed to have formed when the Thames was blocked by an ice sheet advancing south-westwards up its valley, during the Anglian glaciation. Direct evidence for the presence of this ice sheet is provided by the next element of the Moor Mill sequence, the Ware Till. This is a typical 'boulder clay' deposit laid down beneath the advancing ice sheet as it finally extended across the area of the lake. The final deposit in the Moor Mill sequence is a further gravel, this time deposited by the Colne, flowing towards the south-west. The change from a north-eastward-flowing river in the lower gravel to a south-westward-flowing river in the upper gravel thus records the diversion of the Thames from its old route through the Vale of St Albans. The newly formed River Colne, as represented by the upper gravel at Moor Mill, flowed into the diverted Thames at the western end of the vale.

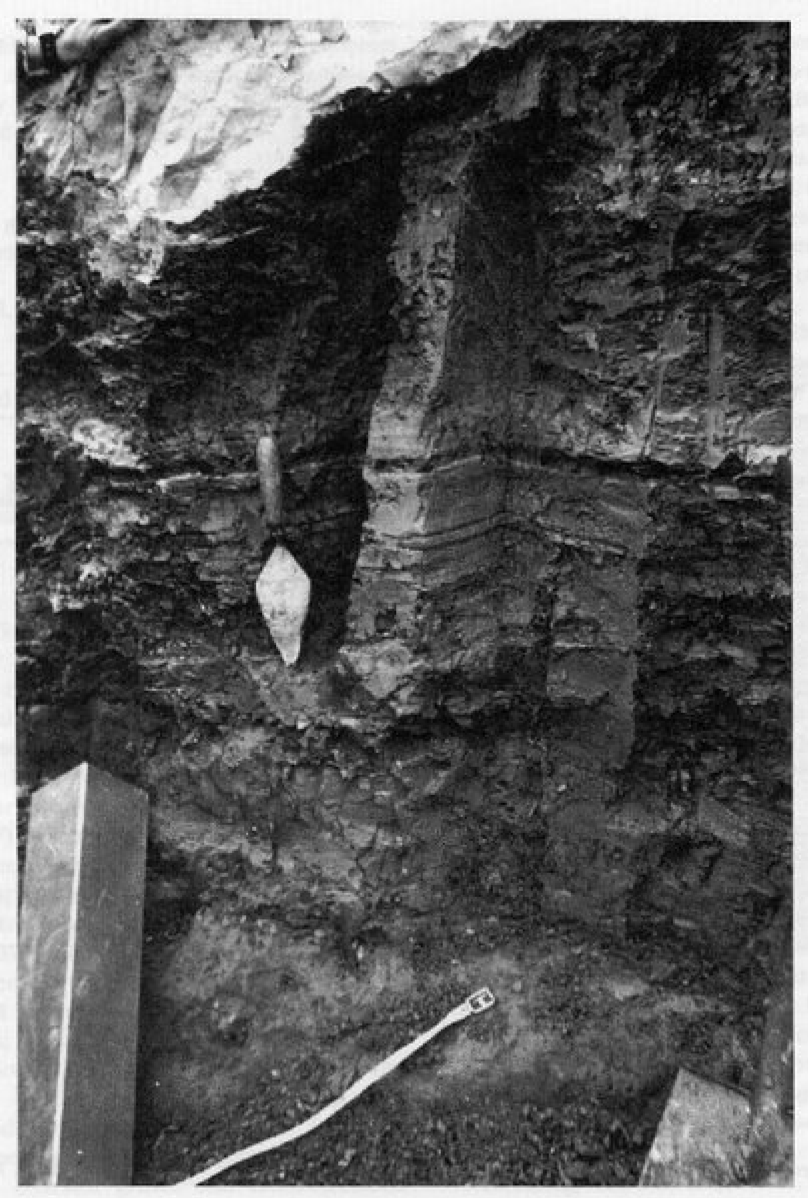
References



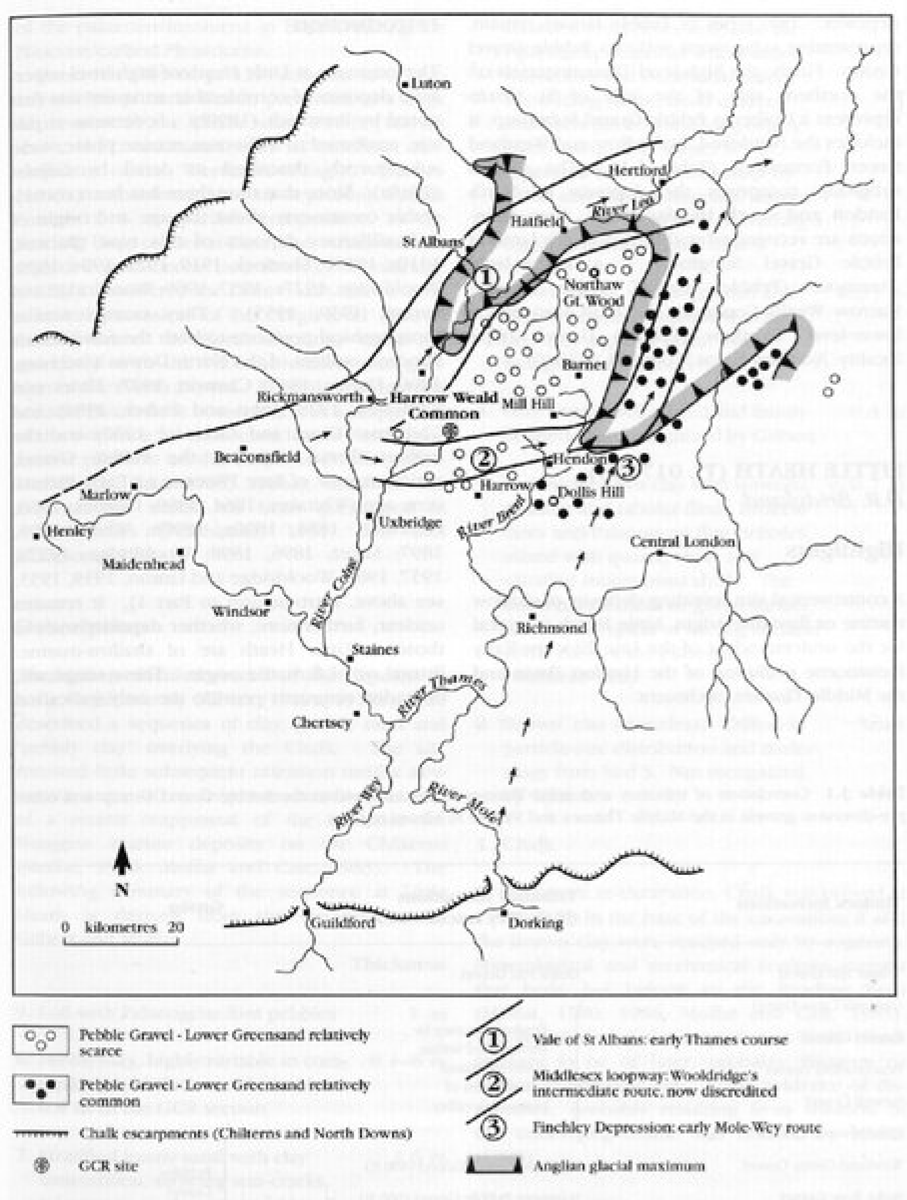
(Figure 3.11) Section in the south face of Moor Mill Quarry, recorded in July 1972 (after Gibbard, 1978d).



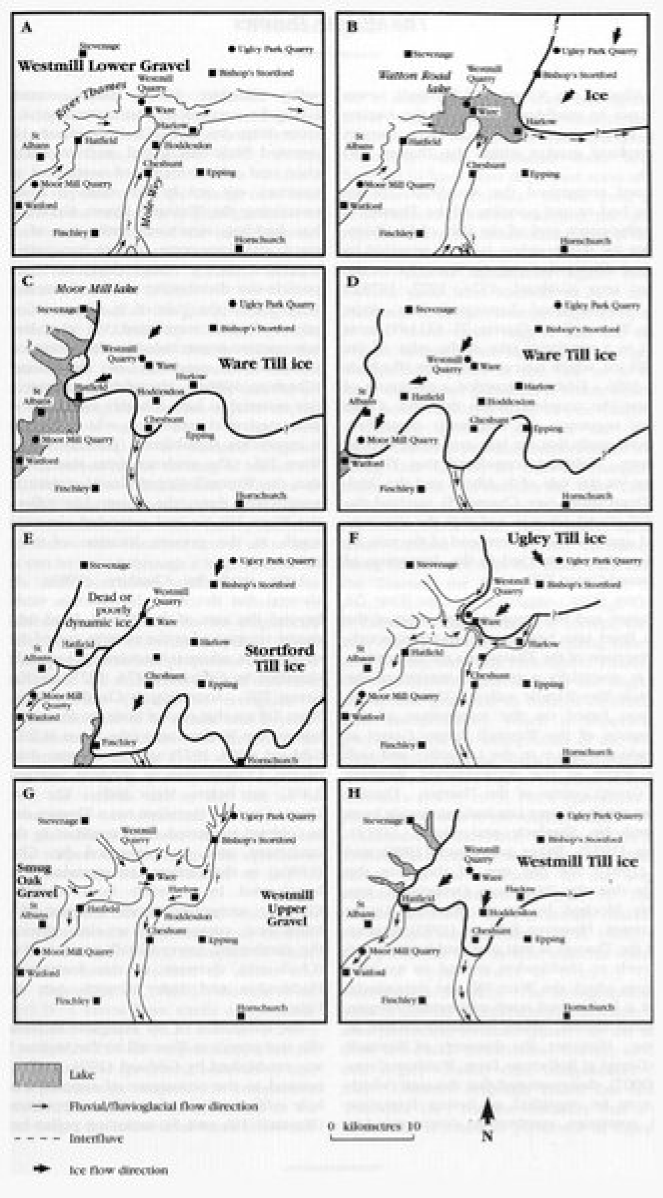
(Table 3.2) Clast-lithological data (in percentage of total count) from the Middle Thames and Vale of St Albans (compiled from various sources). The data concentrates on key sites, GCR sites and localities mentioned in the text. Note that many different size ranges are included and that these yield strikingly different data (this can be observed where results from different fractions from the same deposits have been analysed). As in (Table 4.2), (Table 5.1) and (Table 5.3), the igneous category includes metamorphic rocks (very rarely encountered) and the quartzite category includes durable sandstones. The Tertiary flint category comprises rounded pebbles (sometimes subsequently broken) reworked from the Palaeogene (see glossary with (Table 4.2)).



(Figure 3.12) Detail of laminated lake beds at Moor Mill Quarry. (Photo: P.L. Gibbard.)



(Figure 3.4) Map showing Wooldridge's reconstructed courses of the Thames and its tributary, the Mole–Wey. The distribution of Pebble Gravel remnants is also shown; those remnants in which Greensancl chert is scarce are distinguished from those in which it is relatively common.



(Figure 3.10) Palaeodrainage during key phases of the Anglian evolution of the Vale of St Albans (from Cheshire, 1986a): (A) During deposition of the Westmill Lower Gravel; (B) During the existence of the Watton Road lake; (C) During the existence of the Moor Mill lake; (D) At the maximum extent of the Ware Till ice; (E) At the maximum extent of the Stortford Till ice; (F) At the maximum extent of the Ugley Till ice; (G) During the deposition of the Westmill Upper Gravel and the Smug Oak Gravel; (H) During the Westmill Till ice advance.