Westwood Quarry

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Highlights

This is an important locality for the study of terrace stratigraphy in the Middle Thames basin. The gravels at Westwood Quarry yield possible evidence, in the form of volcanic rocks transported from North Wales, for glaciation in the Early Pleistocene.

Introduction

Westwood Quarry exposes sand and gravel deposited by the Thames when it flowed north of London, through the Vale of St Albans and central Essex, towards East Anglia. These deposits belong to the Gerrards Cross Gravel (Gibbard, 1983, 1985), formerly known as the Lower Gravel Train (Wooldridge, 1938). The upper surface of this formation, where present, forms the Harefleld Terrace of Hare (1947). The sections at Westwood Quarry reveal bedded gravel and sand overlain by probable soliflucted gravel (Green and McGregor, 1978c; McGregor and Green, 1983a, 1983b; Gibbard, 1985). The site is notable for the occurrence, in the upper levels of the bedded gravel, of a clay-enriched and iron-stained horizon of possible pedogenic origin.

Description

The sequence at Westwood Quarry can be summarized as follows (based on published reports and on the re-excavated GCR section):

	Thickness
3. Coarse, very clayey gravel, heavily iron-stained	up to 4 m
2a. Sandy gravel, clay-enriched and mottled (soil developed in top of bed 2)	
2. Sandy, clayey, bedded gravel (Gerrards Cross Gravel)	up to 5 m
1. Chalk, forming pinnacles	

The first description of sections at Westwood Quarry was by Green and McGregor (1978c), who recorded well-bedded sands and gravels (bed 2) overlying 'pinnacled Chalk' and in turn overlain by compact clayey gravel (bed 3). The clayey gravel, which contains a higher proportion of local material than the well-bedded gravel (Table 3.2), was interpreted by Green and McGregor (1978c; McGregor and Green, 1983a, 1983b) as a colluvial deposit. McGregor and Green (1983a) recorded a clast-fabric orientation from the upper gravel suggesting derivation by solifluction from the east, although no high ground now exists in that direction. They also presented palaeocurrent evidence (clast fabrics and foreset orientations) from the fluvial gravel (bed 2) compatible with emplacement by an eastward-flowing river. Surface elevations of 84 m and 88 m were recorded by Green and McGregor (1978a) and Gibbard (1985) respectively.

Similar deposits at Westwood Quarry were recorded by Gibbard (1985), who additionally referred to lenses of brown pebbly clay interbedded with the gravels. He attributed these poorly sorted lenses to mass-movement of material from the valley side. In all these descriptions the effects of solution of the underlying Chalk were noticed; this process has given rise to a pinnacled bedrock surface, to faulting in the overlying gravel and to the formation of pipes and associated collapse structures filled with later, usually fine-grained, sediments. The reddening, mottling and clay enrichment of the upper levels of the lower fluvial gravels (bed 2a) is interpreted as evidence for pedogenesis prior to the accumulation of the upper soliflucted gravel (P.L. Gibbard and J.A. Catt, pers. comms).

Interpretation

A principal part of the geological interest at Westwood Quarry arises from the interpretation of the gravels there as early Thames deposits, laid down at a time when the river flowed through the Vale of St Albans. The history of research leading to this interpretation is long and complex. It was formerly thought that high-level sand and gravel of this type was of glacial origin; early Geological Survey maps show the deposits of this area as 'Glacial Gravel' (Old Series, Sheet 7, 1871; New Series, Sheet 225, 1922; see above, Introduction to Part 2). However, some of the early authors recognized that these high-level deposits are disposed in terrace-like remnants similar to the well-established terraces of the valley gravels (White, 1895, 1897, 1907; Shrubsole, 1898).

It was also observed at an early stage (although not widely accepted until much later) that the far-travelled element of these gravels, mainly quartz, quartzite and chert pebbles from the West Midlands and the Welsh borderlands, are types that have been transported into the London Basin not by ice, but by an ancestral Thames flowing through the Goring Gap (White, 1895). The extension of these ancient gravel deposits from the Middle Thames valley into the Vale of St Albans, rather than along the modern valley through London, was recognized by Salter (1905).

Wooldridge (1938) provided the first systematic subdivision of the belt of old Thames drifts that extends from the Goring Gap to Ware, where it passes beneath true glacial deposits. He recognized three new terrace aggradations at higher levels than those mapped by the Geological Survey, although the two highest are so dissected that he declined to refer to them as terraces. Instead he called them the 'Higher Gravel Train' and the 'Lower Gravel Train'; these occur at 122 m and 113 m O.D., respectively, in the classic Middle Thames area north of Slough. Hare (1947) showed that the Lower Gravel Train is sufficiently well-preserved in the Beaconsfield district to be recognized as a terrace, which he called the 'Harefield Terrace'.

Wooldridge (1938, 1957, 1960; Wooldridge and Linton, 1939, 1955) did not believe that the Thames flowed through the Vale of St Albans after Pebble Gravel times. He suggested that the Lower Gravel Train river flowed in a course via the 'Middlesex Loopway' and 'Finchley Depression' (Figure 3.4), rejoining the earlier northern route near Hertford. Hare (1947) traced this formation (in the form of his Harefield Terrace) to the Harefield area, where he supposed that it entered the 'Middlesex Loopway'. Wooldridge (1957, 1960) perpetuated this view, but no description of Thames gravels in either the 'Middlesex Loopway' or the 'Finchley Depression' was ever provided. Wooldridge (1938) applied the term 'Leavesden Gravel Train' to the deposits now exposed in Westwood Quarry, attributing them to a westward-flowing tributary of the Higher Gravel Train Thames, which he also believed to have flowed through the 'Middlesex Loopway' and the 'Finchley Depression'.

It was later demonstrated, from analyses of the distribution and composition of gravel deposits, that Thames drainage through the Vale of St Albans persisted until the river was diverted by ice during the Anglian Stage (Gibbard, 1974, 1977, 1978a, 1983; Green and McGregor, 1978a, 1978b; McGregor and Green, 1978). Gibbard (1979) also concluded that the 'Finch-ley Depression' was continuously occupied by the Mole–Wey tributary prior to the diversion of the Thames and that the latter river shifted directly from the Vale of St Albans route into its modern course. Gibbard (1974, 1977, 1978a) recognized that the maximum elevation of the fluvial part of the gravel at Westwood Quarry, and its clast composition, indicate that it is part of the Lower Gravel Train, a view supported by Green and McGregor (1978a, 1978b, 1978c; McGregor and Green, 1978). Gibbard proposed the name leavesden Green Gravel' for this aggradation in the Vale of St Albans, but later (1983, 1985) dropped the term in favour of the name 'Gerrards Cross Gravel', which he applied to all the deposits formerly assigned to the Lower Gravel Train.

According to Gibbard, the Gerrards Cross Gravel represents the penultimate phase of terrace aggradation by the Thames in its Vale of St Albans route, the last being the Winter Hill/ Westmill Gravel (Gibbard, 1977, 1978a, 1983, 1985). The deposition of the latter immediately preceded the glaciation of the Vale of St Albans and the resultant diversion of the Thames (see below, Moor Mill and Westmill). Remnants in the Reading–Henley area of an intermediate Rassler Gravel Formation, previously recognized by Sealy and Sealy (1956), are here attributed to aggradation by the Thames in the interval between the deposition of the Gerrards Cross and Winter Hill Formations (see Chapter 1; (Figure 3.2)).

The clast composition of the Gerrards Cross Gravel shows it to be the richest of all the Thames terrace formations in exotic material from beyond the present catchment (McGregor and Green, 1978, 1983b, 1983c, 1986; Green *et al.,* 1980; Gibbard, 1985; (Table 3.2)), particularly the familiar volcanic (including pyroclastic) pebbles that are believed to come from North Wales (Hey and Brenchley, 1977; Green *et al.,* 1980; Whiteman, 1983). McGregor and Green (1983b) noted that these igneous clasts are concentrated in certain areas, perhaps suggesting the localized fragmentation of larger ice-rafted blocks, and that the proportions of the various types differ from those in the Kesgrave Sands and Gravels of Essex and Suffolk, where they have also attracted attention. Despite his agreement that these exotic lithologies 'reach their acme' in the Gerrards Cross Gravel, Gibbard (1985, p. 16) presented data that shows twice as much igneous material (8–32 mm size range) in the Beaconsfield Gravel (average 0.46%) as in the Gerrards Cross Gravel (average 0.23%). Gibbard did, however, record high levels of igneous rocks at Westwood Quarry (average 0.44%). Data from 11.2–16 mm clast counts published by Green and McGregor (1978a, 1983), Green *et al.* (1980) and McGregor and Green (1986) clearly indicate that the highest frequencies of volcanic clasts occur in the Gerrards Cross Gravel; the record of 3.16% volcanics in a sample from the M1 motorway (McGregor and Green, 1986) appears to be the highest value from any of the various Thames formations.

The occurrence, in the Gerrards Cross Gravel, of the highest frequencies of igneous material within the Thames terrace succession has led to the suggestion that deposition of this formation coincided with a glacial advance from Wales and the north-west into the upper reaches of the catchment (Green and McGregor, 1978a). Since the Gerrards Cross Gravel is older than the Winter Hill Gravel, which immediately pre-dates the Lowestoft Till, this Welsh glaciation must have been earlier than any that occurred during the Anglian Stage. After comparison with the influx of far-travelled material into East Anglia in the Early Pleistocene (Hey, 1976b), Green and McGregor (1978a) suggested that a glaciation of Baventian age, or of post-Baventian/pre-Anglian age, had introduced exotic material into the Thames catchment during the deposition of the Gerrards Cross Gravel and, probably, on earlier occasions. Bowen *et al.* (1986a) interpreted the occurrence of such materials in the various early Thames formations as evidence for repeated glaciation in upland Britain. However, Gibbard (1983, 1985) favoured an early Anglian age for the Gerrards Cross Gravel and any corresponding glaciation of the upper reaches of the catchment. He reported that the study of sand-grain surfaces by scanning electron microscope had revealed little evidence for a proximal glacial source of the Gerrards Cross Gravel.

The recognition in this volume of an additional terrace formation in the Middle Thames between the Gerrards Cross and Winter Hill Gravels (above; see Chapter 1) makes an early Anglian age for the Gerrards Cross Formation unlikely. The conclusions of Whiteman (1990), and their implications for correlation between the Thames sequence and that in East Anglia (see Chapter 1), indicate that the Gerrards Cross Gravel is very much older than the Winter Hill/ Westmill Formation. Early attempts to correlate the Gerrards Cross Gravel with parts of the Kesgrave Sands and Gravels (Green *et al.,* 1982; Green and McGregor, 1983; McGregor and Green, 1986; Bowen *et al.,* 1986a) were based largely on Hey's (1980) projection of the Westland Green Gravels into East Anglia, although Bridgland (1988a) also used deposits related to the Anglian glaciation and its diversion of the Thames within Essex as a stratigraphical marker. Whiteman's work suggests that the Gerrards Cross Gravel is the direct correlative of the deposits in Suffolk and Norfolk identified by Hey (1980) and Allen (1983, 1984) as Westland Green Gravels. The implication of this is that the sequence of lower pre-diversion gravels (Low-level Kesgrave Subgroup — see Chapter 5) recognized in southern East Anglia is poorly represented in the Middle Thames valley, there being a major gap in the terrace succession in the latter area between the Gerrards Cross and Winter Hill Formations. The suggested correlation of the early Thames gravels in Suffolk and Norfolk with the East Anglian sequence (Hey, 1980; see above and Chapter 1) points to an Early Pleistocene age for the Gerrards Cross Gravel, implying that deposition of the Westland Green and Winter Hill Gravels was separated by a considerable period of time, including the entire early Middle Pleistocene. The poorly preserved Rassler Formation, recognized in the Reading area (Chapter 1), appears to be the only deposit in the Middle Thames that represents part of this interval.

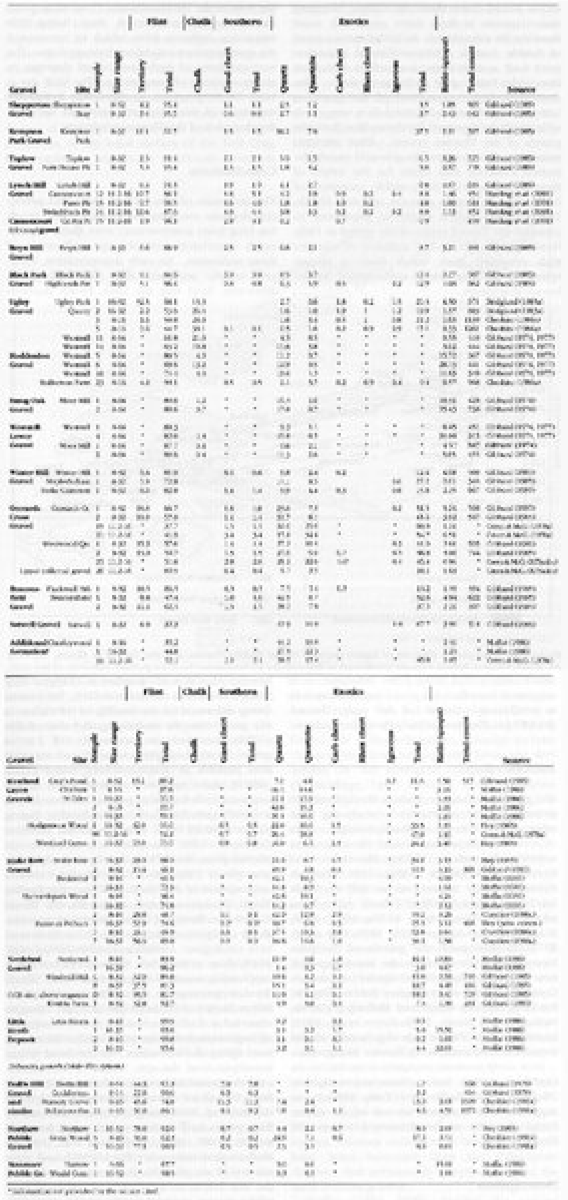
Whiteman's views represent a considerable challenge to workers in the Middle Thames valley, which has long been held to be the classic area for studies of the river's development. If his correlation scheme is correct, the pre-Anglian sequence in East Anglia is considerably more complete than that in the Middle Thames. Whiteman has interpreted the Gerrards Cross Gravel as the last aggradation by the 'Severn-Thames', subsequent formations reflecting a river, much reduced in size, that had lost its headwaters beyond the Cotswolds escarpment. The coincidence of this formation with the peak in exotic gravel lithologies suggests that a fairly major Early Pleistocene glaciation may have occurred at this time. This raises the possibility that this glaciation may have influenced fluvial evolution in the area beyond the Cotswolds and may have been responsible for diverting the drainage of this area away from the Thames, probably into the Trent system (which was represented at that time by a river flowing from southern Lincolnshire into northern East Anglia, the 'Ingham River' (Rose, 1987, 1989; Bridgland and Lewis, 1991)).

Little is known about the palaeosol that occurs in the upper levels of the Gerrards Cross Gravel at Westwood Quarry. This may be of similar origin and age to the Valley Farm Soil, which is developed on the Kesgrave Sands and Gravels in East Anglia (Rose *et al.,* 1976; Rose and Allen, 1977; Kemp, 1985a; see Chapter 5, Newney Green), and may therefore provide further evidence for correlating the Gerrards Cross Formation with divisions of the Kesgrave Group. Apart from the widely recognized Valley Farm Soil, the occurrence of a buried palaeosol is an extreme rarity within the Thames terrace sequence. Study of the soil horizon at Westwood Quarry may produce corroborative evidence for the great age of the Gerrards Cross Gravel implied by Whiteman's interpretation of Lower/lower Middle Pleistocene Thames stratigraphy.

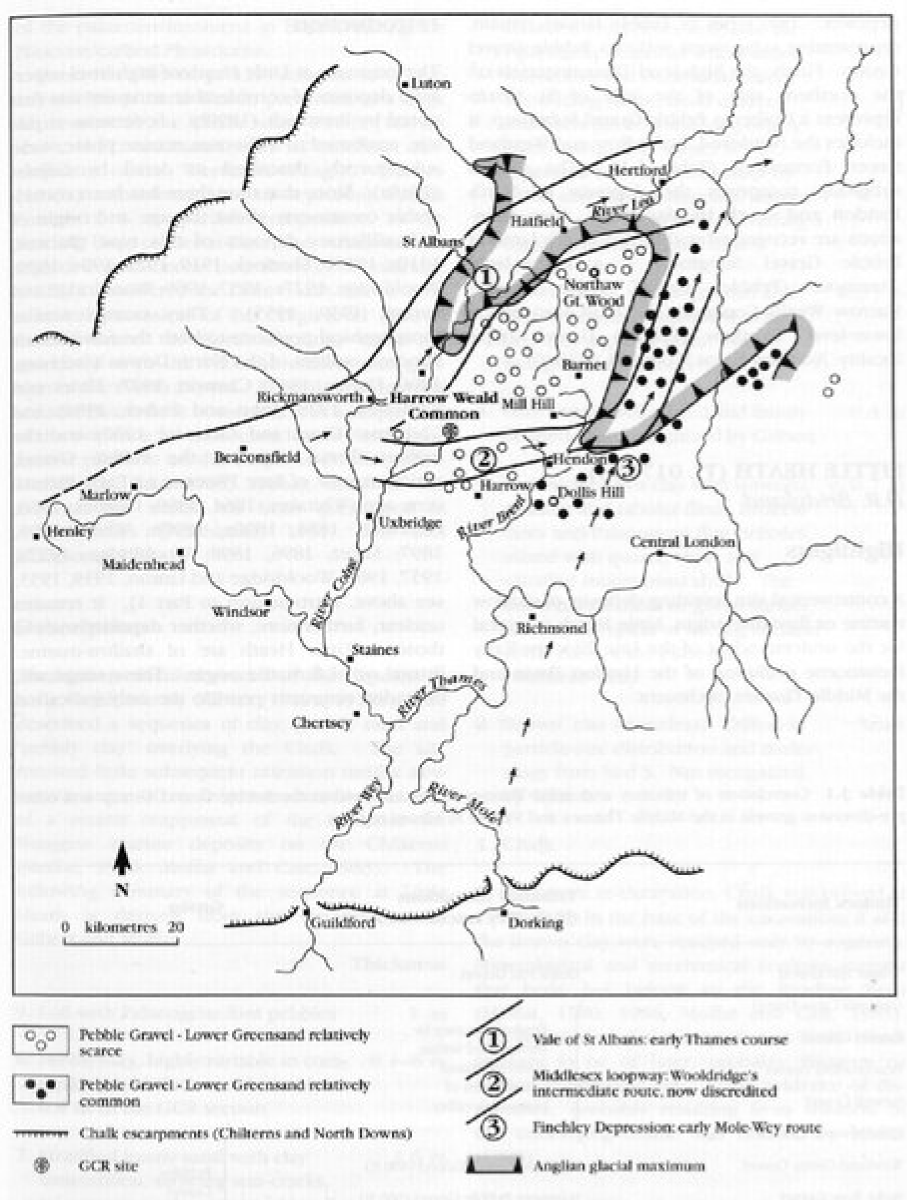
Conclusion

The Gerrards Cross Gravel, exposed at Westwood Quarry, charts the course of the early River Thames, which once flowed through the Vale of St Albans towards eastern Hertfordshire and East Anglia. This river brought with it exotic rocks from as far afield as the West Midlands and North Wales. Such evidence has been used to suggest that, at this time (probably over three-quarters of a million years ago), the Thames drained a much larger area than at present. Some workers believe that glaciation in the upland area of North Wales brought some of the more exotic rock-types into the Thames catchment. If so, this is a rare indication of glaciation prior to the growth of the well-known Anglian ice sheets, about 450,000 years ago.

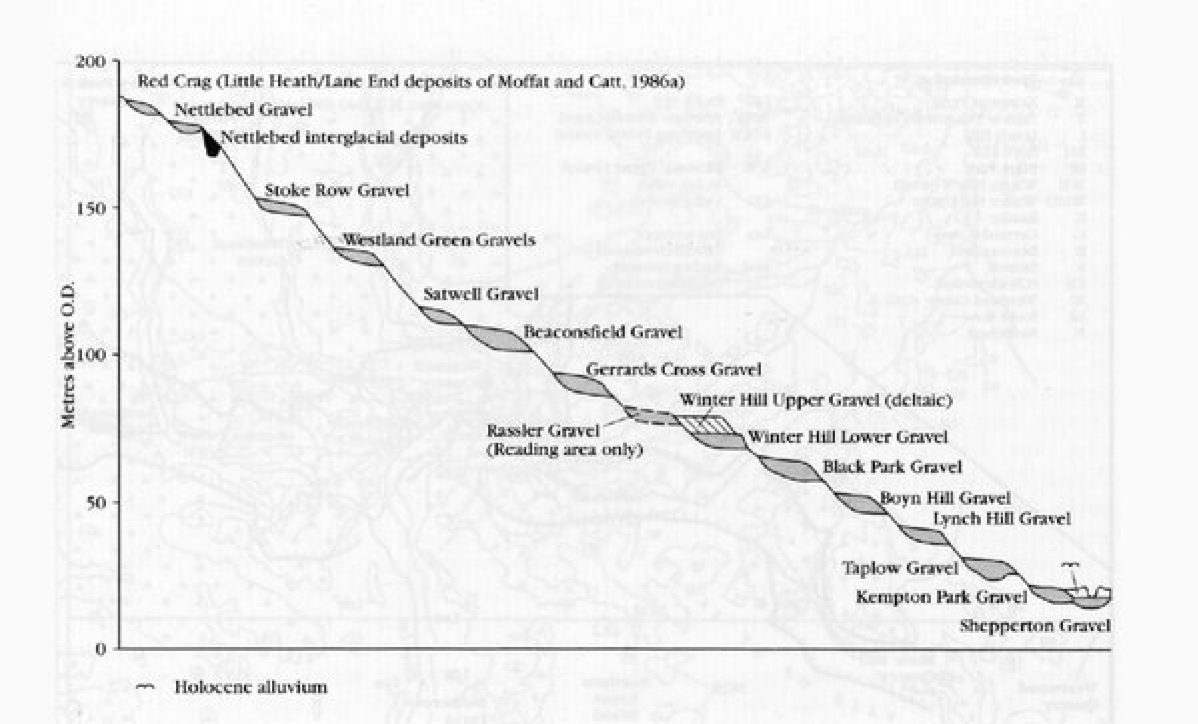
References



(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 3.4) 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 3.2) Idealized transverse section through the classic Middle Thames sequence of the Slough-Beaconsfield area. The stratigraphical position of the Rassler Gravel, not preserved in this area, is shown.