The geology of the Pleistocene deposits between Coventry, Rugby and Hinckley, English East Midlands

Bridge, D. McC, Carney, J.N. Horton, A, Lawley, R.S.L. and Sumbler, M.G.

A field guide for the Royal Geographical Society excursion held on 10 May 1992

British Geological Survey Technical Report WA/92/40

Geographical index: UK, East Midlands, Coventry, Rugby, Hinckley

Subject index: Geology, Pleistocene, Drift, Field guide

Bibliographic reference: Bridge, D. McC. Carney, J.N. Horton, A, Lawley, R.S.L. and Sumbler, M.G. 1992 The geology of the Pleistocene deposits between Coventry, Rugby and Hinckley, English East Midlands British Geological Survey Technical Report WA/92/40

Contents

Figures

(Figure 1) Summary of stratigraphical relationships in the Drift succession.

(Figure 2) Geological setting of the East Midlands Drift succession.

(Figure 3) Composite cross sections showing relationships within the Drift deposits in the Coventry district.

(Figure 4) Section in the Baginton Sand and Gravel at Huncote Pit.

(Figure 5) Section in the Shawell Gravel, Oadby Till and 'undifferentiated glaciofluvial deposits' at Gibbet Lane Quarry.

(Figure 6) Location of Wolston Pit and Frog Hall Quarry.

(Figure 7) Simplified geological map and location of sections at Wolston Pit and Frog Hall Quarry see (Figure 8) and (Figure 9). A = Frog Hall Quarry.

(Figure 8) Geology at Wolston Pit (from Shotton, 1953, figure 10); see (Figure 7) for line of section. The lateral position of the extant face is indicated. N.B. the 'boulder clay' included within the Lower Wolston Clay (W.L.C.) is now classified as Thrussington Till.

(Figure 9) Cross-section showing the relationship of the Frog Hall Sand and Gravel (FSG) to the Wolston 'Series' (from Sumbler, 1989, figure 3). Other ornaments as in (Figure 7).

(Figure 10) Locality map of the auger traverse at Stretton Wharf.

(Figure 11) Wolston Pit. Wolstonian glacial deposits. Wolston Gravel Pit, now largely backfilled, has been designated the type locality of the Wolstonian stage of the Pleistocene. At the top of the face can be seen the Wolston Sand, partly overlain by loamy hillwash. Beneath are smooth grey and brown clays, representing the Wolston Lake Deposits. The Baginton Sand outcrop is concealed by slipped clay and vegetation. British Geological Survey image: P212262.

Table

1 General stratigraphy of the glacial drift

1. Introduction

Although it is some 40 years since Professor F W Shotton published his detailed account of the glacial succession in the English Midlands (Shotton, 1953), many aspects of the glacial geology continue to provoke lively discussion and controversy. In the course of this field meeting, it is hoped to illustrate the glacial geology of the area between Warwick and Leicester, and examine the evidence for the development and subsequent extinction of 'Glacial Lake Harrison'. Much of the information presented is based on recent BGS mapping but the guide also draws heavily on published works, notably by Rice (1968, 1981), Douglas (1980), Sumbler (1983), Old and others (1987) and Rice and Douglas (1991).

The glacial sequence is composed of several members (Table 1) and was originally designated the stratotype for the penultimate British glaciation, the Wolstonian Glacial Stage' of Shotton and West (1969). However, the status of this glaciation is now considered questionable (Perrin and others, 1973; Sumbler, 1983) and many workers now believe the deposits to be older, and probably contemporaneous with the deposits in East Anglia which belong to the Anglian Glacial Stage.

The nomenclature used throughout this guide follows that of Sumbler (1983).

2. Interpretation of the Glacial Drift

The glacial succession is considered to represent a full cycle involving initial climatic cooling, onset of glaciation, then deglaciation. Based on the lithostratigraphy (Table 1) and the perceived correlations (Figure 1), a possible sequence of events can be envisaged as follows:

The development of the 'Proto-Soar' river

A reconstruction of the rockhead surface beneath the district (Figure 2) shows that the oldest Quaternary deposit, the *Baginton Sand and Gravel,* is restricted to a palaeovalley running partly beneath the present valley of the Avon but sloping towards the north-east and passing into the modem Trent basin. The base of the valley falls from about 90m OD near Stratford upon Avon to below 60m near Leicester. Shotton (1953) has interpreted this depression as a pre-glacial valley of the 'proto-Soar'. The fluvial origin of the associated sediments is clearly seen at Huncote Pit, where well-sorted, fine- to medium-grained sands are arranged in a series of cross-bedded units that testify to deposition by northeastward-flowing water. The flora and fauna of the Baginton Sand and Gravel, described by Shotton (1953) and Kelly (1968) amongst others, demonstrate a change from a boreal to a cold climate. Ice-wedge casts within the upper part of the Baginton Sand and Gravel at Huncote Pit confirm the increasing severity of the climate in the latter stages of the proto-Soar's development.

Advance of 'Thrussington Till' ice

The first evidence for full glacial conditions is given by the *Thrussington Till,* which forms a sheet normally 3 to 5m thick, resting with sharp contact on the Baginton Sand and Gravel or on local bedrock (Figure 3). The till, which is seen at Huncote Pit, is a matrix-dominated stony clay, typically reddish brown in colour and containing a predominance of Triassic erratics. The chaotic internal structure in the main body of the deposit suggests it was laid down as a lodgement till. The erratic rock types establish a general direction of ice flow from the north or north-west around the margin of the Warwickshire Coalfield. However, the presence, locally, of lenses of brown till containing chalk, flint nodules and Liassic clasts points to an early input of material from a more easterly source.

(Table 1) General stratigraphy of the glacial drift

Member	Lithology	Interpretation
6. Dunmore Gravel	Sandy and clayey gravel, containing flint and 'Bunter' quartzite pebbles	Outwash sandur/glaciofluvial terrace remnants associated with decay of the Oadby Till
5.Oadby Till	Stiff grey clay with erratics of chalk, flint and Jurassic limestone	Lodgement till of eastern or north-eastern provenance
4.Wolston Sand and Gravel	Red or yellow fine- to medium grained sand	Distal sandur
Shawell Gravel	Yellow, medium-coarse grained pebbly sand with lenses of flint-rich gravel	Proximal glaciofluvial outwash
3.Wolston Clay	Reddish brown and grey-brown clay, laminated in part, with dropstones	Glacial lake deposits
2. Thrussington Till	Reddish brown clay with a predominance of Trias-derived sandstone and siltstone erratics	Lodgement till of north or north-westerly provenance
1. Baginton Sand and Gravel	'Bunter'quartzite-rich gravel overlain by fine- to medium-grained, well-sorted sand	Fluvial deposit

Glacial Lake Harrison

Lacustrine deposition was initiated early in the glacial cycle, possibly triggered by a slight climatic amelioration. Evidence of local ponding is first seen at the top of the Thrussington Till where beds of laminated clay alternate with till. Glaciolacustrine conditions became more firmly established in *Wolston Clay* times when sequences of brown silts and clays, locally laminated and containing ice-rafted dropstones, were deposited over wide areas of the Proto-Soar catchment (Figure 2).

Shotton regarded the Wolston Clay as accumulating in a single large proglacial lake impounded to the north and southwest by ice, and to the east and west by higher ground. At its maximum, he considered it to have extended from Market Bosworth in the north, to Moreton-in-the-Marsh in the south. Dury (1951), in trying to identify the original extent of the proglacial lake, drew attention to topographic benches on the Jurassic scarp, which he regarded as evidence for a former shoreline. Several cols on the scarp were suggested as possible overflow channels (Bishop, 1958). Subsequent studies e.g. Ambrose and Brewster, 1982) have shown that the geomorphological features mapped by Dury are probably unrelated to a lake shoreline but simply reflect hard bands within the Lower Lias bedrock.

Sumbler (1983), working in the south of the region has disputed the model of a single vast lake, suggesting instead that the Wolston Clay was deposited in smaller transient glacial lakes and ponds which migrated with the advancing ice sheets. The succession in the neighbourhood of Wolston Pit supports this view; here the Wolston Clay locally contains bodies of till-like material suggesting the proximity of ice.

Recent mapping in the north of the region seems to confirm that in the lower part of the Proto-Soar catchment, Shotton's view of a single, semi-permanent body of water may be correct. Here the Wolston Clay forms an undivided sequence, which thickens northwards (Figure 3), reaching nearly 50m in the Hinckley arm of the palaeovalley. Varying in the deposits suggests that sedimentation continued for a lengthy period, possibly of the order of 10 000 years (Douglas, 1980). When the water level finally fell, a pro-glacial sandur (the *Wolston Sand and Gravel*) accumulated on the surface of the lake clays. Farther to the south, the evidence for a single lake is less convincing; the Wolston Clay is thinner and correlatives of the Wolston Sand and Gravel occur at different stratigraphic levels within the lacustrine sequence (Sumbler, figure *2c,* 1983), which Shotton divided into 'upper' and 'lower' units (Table 1).. In these marginal areas of the proto-Soar catchment the model envisaged by Sumbler would seem more applicable. At Stretton Wharf, west of Stretton Under Fosse village, an auger traverse will be carried out to illustrate the stratigraphy in an area marginal to the main glaciolacustrine sequence.

Advance of ‘Oadby Till' ice

Towards the end of the glacial cycle, ice with entrained Jurassic and Cretaceous clasts advanced into the region probably from the north or north-east, laying down the *Oadby Till as* a bluish grey lodgement till, and more localised spreads of coarse fluvioglacial outwash known as the *Showell Gravel,* both of which can be seen at Gibbet Lane Quarry. In the northeast of the region, the ice advance caused extensive glaciotectonic disturbance involving thrusting and folding of the pre-existing glacial sequence. Ice-loading of the plastic and highly defonnable Wolston Clay appears to have been a major factor contributing to the deformation.

Ice decay

Decay of the 'Oadby Till' ice (Shotton, 1976) was accompanied by extensive glaciofluvial deposition, mainly of sandy and clayey gravels. The resulting deposits, termed the *Dunsmore Gravel* by Shotton, form disconnected outcrops to the north and south of the River Avon. The base of the deposit is a surface of erosion and, in places, deeply channelled suggesting that rather than being sandur deposits, they may be instead the remnants of a once extensive system of fluviatile terraces, developing perhaps as forerunners to the modern Soar and Avon river systems.

Erosion of the Drift deposits

The Soar and Avon drainage systems, which probably were initiated at the time of deposition of the Dunsmore Gravel, continued to cut downwards through the earlier glacial deposits forming a series of localised river terraces. The oldest of these, which is demonstrably younger than the Dunsmore Gravel and Wolston Clay (Sumbler, 1989), contains deposits of the *Frog Hall Sand and Gravel* seen at the Frog Hall Quarry.

3. Localities to be visited

All of the localities are shown on (Figure 2). They are described below in approximate order of visit, however, the final itinerary may vary according to time constraints on the day.

A. Huncote Pit–Baginton Sand and Gravel and Thrussington Till [SP 585 985]

The Huncote Pit provides the best section through the Baginton Sand and Gravel in the Leicestershire region, and has previously been described by Shotton (1953) and Rice (1981) amongst others. The section was briefly studied during the recent BGS mapping programme for Sheet 169 (Coventry), to assist in the mapping of the Baginton Sand and Gravel farther south.

The sedimentary log (Figure 4) is a composite of five sections in the quarry, chosen to represent the overall nature of the deposit.

Basal gravel facies

Originally termed the Baginton-Lillington Gravel (Shotton, 1953; Rice, 1981), the basal gravel facies has a maximum thickness of 10m and rests on an uneven bedrock surface of Mercia Mudstone.

The gravel beds are massive, with channelised bases and limited internal structure. They mainly contain well-rounded 'Bunter' quartzite and locally derived diorite pebbles, with subordinate sub-rounded Triassic sandstone and well-rounded Jurassic limestone pebbles and tabular fragments of grey siltstone; the fossil *Gryphaea arcuata* is present throughout the gravel. Locally the clasts are supported by a matrix consisting of either yellow, medium to coarse sand, or red mudstone debris. Several beds near the base of the gravel consist entirely of weathered mudstone debris and 'Bunter' quartzite pebbles; they are interpreted as deposits formed by the localised reworking of gelifluxion material.

Lenticular beds of medium to coarse-grained sand with channelised bases and undulose, eroded top surfaces, are present throughout the gravel. They vary in composition, locally containing coal, Mercia Mudstone and siltstone 'rip up' clasts, usually aligned along cross-bedding foreset surfaces. Planar cross-bedding, horizontal lamination and trough cross-bedding features are common, and some beds show 'reactivation' surfaces indicating rapid changes in the rate of discharge and deposition in the river system.

Baginton Sand

The Baginton Sand comprises up to 6.5m of yellow sand beds, many with thin basal pebble lag deposits. Overall, the deposit fines upwards from coarse, pebbly sands at the base, to finer and cleaner sands which in turn are capped by silty beds forming the top of the sequence. At outcrop scale, the Baginton Sand displays a complex pattern of bedfomis associated with meandering channels and sheet deposits.

Pebbly beds are common throughout and are particularly numerous towards the base of the unit, where reworking of the underlying gravel may have taken place. The pebbles mainly comprise 'Bunter' quartzite or locally-derived diorite, with smaller fragments of Mercia Mudstone and siltstone concentrated along many erosion and cross-bedding surfaces. Most of the pebble beds form 'lag' deposits at the bases of individual sand beds.

The sand beds are composed of sub-rounded and spherical grains. The silt and clay content is variable, with silty beds predominant as a succession of 'overbank' deposits at the top of the unit. Locally, coal forms flakes or angular fragments concentrated and aligned along cross-bedding foresets; the likely source for this material is the Warwickshire Coalfield, which crops out between Coventry and Nuneaton. Planar cross-bedding and laminar bedding are predominant, with 'trough' cross-bedding and climbing ripple laminations better developed in the more channelised sand bodies. Numerous 'cut-off' and erosion surfaces can be seen in the main working face of the pit.

The Baginton Sand is dominated by channelised sand bodies reflecting the low-sinuosity braided river system in which they were deposited. Reactivation surfaces, indicative of varying discharge rates, and channel fill deposits are exposed at several points in the working face, with fine to coarse-grained sheet-flow (flood) deposits forming the more laterally persistent beds.

Inclinations of planar cross-bedding foresets, climbing ripple laminations and imbricated pebbles, indicate a dominant flow to the north-east see (Figure 4), in slight disagreement with the measurements of Rice (1981), which suggest northerly as well as northeasterly flow directions.

Shotton (1953) and Rice (1981) have reported ice wedge casts in the Baginton Sand and Gravel at Huncote. They are not common, only occasionally being revealed in the course of the excavations.

The Baginton Sand and Gravel is overlain by interdigitated lenses of 'chalky' and 'Triassic' facies of the Thrussington Till. This deposit has been described in some detail by Rice (1981), and includes glaciofluvial sand deposits of uncertain origin. Some of these are faulted against the till, which in places is sheared indicating glaciotectonic disturbance of the succession.

B. Gibbet Lane Quarry–Shawell Gravel, Oadby Till and 'undifferentiated glaciofluvial deposits' [SP 5396 8067]

The Shawell Gravel represents glacial outwash deposits wholly intercalated within the Oadby Till. It was named by Sumbler (1983), who correlated it with the upper of two beds of Wolston Sand and Gravel developed east of Harborough Magna. The Gravel thins out to the west of grid line 51 in this study area (Figure 2) but is more extensive farther east, in the adjoining Market Harborough district, where it locally forms the basal drift member (Poole and others 1968). Recent BGS mapping has shown that in the Coventry map district at least, the Shawell Gravel is separated from Wolston Sand and Gravel by an intervening bed of the Oadby Till which is between 10 and 20m thick.

A complete section in the Shawell Gravel is currently exposed at Gibbet Lane Quarry (Figure 2). The Gravel, which both rests on and is overlain by Oadby Till, is 10m thick and predominantly medium to thickly-bedded (Figure 5). It is composed of two principal facies types.

The *clast-supported gravel facies,* principally found in the basal and upper parts of the section, forms tabular, sheet-like beds which either are massive or show internal clast imbrication. The predominant clast types are of angular flint and rounded 'Bunter' pebbles. The gravel beds are laterally continuous, resembling the deposits of unconfined sheetflows (e.g. Flint and Turner, 1988).

More prevalent is the *cross-bedded sand facies* which, however, also contains thin lenticles or basal lags of flint-rich gravel. The grey sands in the lower 2.3m of the section typically have granule-sized clasts of coal and dark shale concentrated along the foresets; such material includes jet indicating a Jurassic provenance for at least some of this material. Higher up the sands are orange or yellow, though with coaly material still locally present. Sand facies beds are commonly lenticular, with channelised bases and eroded topsurfaces. Planar cross-bedding, with foresets dipping between 20 and 40°, is the predominant internal structure. Within cross-bedded sets grain size sorting, sometimes accompanied by grading, produces alternations between medium and coarse-grained or pebbly layers; avalanche foresets, where grain size increases towards the bottom of each set, are also developed. Sand facies beds may also show reactivation surfaces, trough cross-bedding and climbing-ripple cross-lamination, all sporadically developed in the lower 6m of the section.

Inclinations of planar cross-bed foresets show a dominant current flow from south-west to north-east, with subordinate beds indicating north-west, south-west and south-east directed currents in the lower 8m of the section. Beds near the top of the main face, only observable from a distance, indicate a reversed current flow, from north-east to south-west.

In its variety and complexity of bedding structures the Shawell Gravel is comparable with the deposits of modem braided river systems fed by glacial meltwaters (e.g. Smith, 1974). The planar cross-bedded sets with coarse avalanche foresets are similar to the low-profile bedforms produced by longitudinal or transverse gravel or sand bars which advance by means of slippage or avalanching at the downstream end. Reactivation surfaces indicate that these bars formed under conditions of fluctuating discharge rates. The medium-grained sands that sometimes overlie the coarser beds, and which occasionally show climbing ripple cross- lamination, are interpreted as bar-top deposits formed at tunes of low discharge. More commonly, bar surfaces were eroded by later bars or by meandering braid channels. The latter, formed during the low discharge phase of the river, are represented by the trough cross-bedded sands which are occasionally channellised into the planar-bedded layers. Lateral accretion structures have not been found, indicating that the rivers depositing the Shawell Gravel were predominantly of moderate to low-sinuosity type.

Accumulation of the Shawell Gravel under glacial conditions is indicated by the observation of ice wedge casts in the middle part of the section.

The Oadby Till overlying the Shawell Gravel represents a late re-advance of the ice sheet across this area. Its thickness of 2–3m at Gibbet Lane is due in part to erosion and in part to thinning across the top of the Shawell Gravel, since elsewhere it is 12 m thick. The matrix of the till consists of dark blue-grey clay of probable Liassic derivation. Erratics comprising about 25 to 30% of the deposit are generally smaller than cobbles with a large proportion being of granule or small pebble-size; chalk, flint, Jurassic limestone and 'Bunter' pebbles are the main compositional types. These clasts are randomly orientated. A 2m-wide raft of Shawell Gravel has been found enclosed in the till, which becomes browner and sandier in its upper part, particularly on the western face of the quarry.

Undifferentiated glaciofluvial deposits overlie the Oadby Till at the top of the western quarry face. They occupy a broad channel which cuts down almost to the basal contact with the Shawell Gravel. The basal bed, which infills the deepest part of the channel, is an orange-brown, poorly-sorted and matrix-supported conglomerate. It is overlain gradationally by a similarly poorly-sorted, though finer-grained, pebbly sand with carbonaceous layers. The highest bed fines upwards from a poorly-sorted, matrix-supported cobble conglomerate to a medium-grained or silty sand at the top.

Deposits of similar type farther west form veneers or channelised bodies on the Oadby Till surface, and are thought to belong to the same end-glacial phase of erosion that produced the more extensive bodies of Dunmore Gravel. Normal grading in the Gibbet Lane beds is comparable with that seen in sheetflow deposits described by Flint and Turner (1988). Sheetflow is described as a relatively high-frequency and low-magnitude type of process by Hogg (1982), and this is compatible with a climatic regime of high precipitation following final glacier retreat.

C. Wolston Pit–Lower Wolston Clay and Wolston Sand and Gravel [SP 410 746]

The geographic and geological setting of this quany are shown in Figure 6) and (Figure 7). Wolston Pit was formerly an extensive working in Baginton Sand and Gravel. Mineral extraction ceased many years ago, and the pit became a refuse dump used principally for industrial waste from Coventry. It became notorious in the 1970's because of 'cyanide' dumping; the resultant public outcry led eventually to legislation controlling the disposal of toxic waste.

The site is a classic geological locality, having given its name to Shotton's (1953) Wolston Clay' (glaciolacustrine clays of 'Lake Harrison') and the Wolston Series' (comprising the Wolston Clay and the associated glacial deposits). The succession at Wolston Pit was originally thought to correspond to the penultimate British Glacial period (ending c. 125 000 years ago) which was consequently named the 'Wolstonian Stage' (Mitchell and others, 1973). Many workers now think that the deposits at Wolston are much earlier, contemporaneous with the 'Anglian' glacial deposits of East Anglia (perhaps c. 450 000 years old). However, the Woistonian Stage is firmly established in the geological literature as a period of geological time, and as yet a more appropriate name has not been formally proposed.

Because of its geological importance, Wolston Pit was scheduled as a Site of Special Scientific Interest (SSSI) in 1981. Unfortunately, because of continued tipping and the nature of the sediments themselves, little of the original section remains visible (Figure 8), but the upper part of the succession has been excavated for our visit. The succession in the pit (measured by MGS in 1977) and that proved by boreholes in the field to the south (Shotton, 1953; Figure 10) is as follows:

Dunsmore Gravel	1.8 metres
Upper Wolston Clay	6.7
Wolston Sand and Gravel	5.2
Lower Wolston Clay	1.3
Thrussington Till	3.6

Baginton Sand and Gravel	5.8 to 9.2

The excavated section shows the basal c. 1m of the Wolston Sand and Gravel, comprising medium to coarse-grained red sand, with silt lenses and a basal layer of small, mainly Trias-derived pebbles. The underlying Lower Wolston Clay is a dark purple, grey and brown mottled clay with silt laminae. The Thrussington Till is essentially as seen elsewhere; it comprises a tough red clay containing debris of greenish sandstone and siltstone and other rocks, principally derived from the Triassic outcrop to the north.

D. Frog Hall Quarry–Upper Wolston Clay and Frog Hall Sand and Gravel [SP 416 736]

Frog Hall Quarry (Figure 6), (Figure 7) and (Figure 9), opened in 1988, lies c. 1km south-east of Wolston Pit. It exploits a deposit of flint-rich gravel with sand seams interpreted by Shotton (1953) as Dunsmore Gravel, but shown by BGS mapping to be a separate, younger deposit. This 'Frog Hall Sand and Gravel' infills a north-south trending channel cut into the Wolston Clay, and which is probably correlative with the oldest (Fourth) terrace deposit of the River Avon (Sumbler, 1989). Recently, mollusc shells have been obtained from silts within the Frog Hall Sand and Gravel; these have been dated by amino acid geochronometry and give a Hoxnian (pre-Wolstonian) age, supporting the view that the underlying (and consequently older) Wolston Series is of Anglian age (Keen, Coope and others, in prep.)

In the context of the present excursion, the main interest of the pit is that the side of the channel is sporadically exposed, showing Upper Wolston Clay. This is somewhat similar to the Lower Wolston Clay of Wolston Pit, but contains sporadic pebbles, probably drop-stones deposited by melting ice-masses floating in the waters of 'Lake Harrison'. The pebbles are mainly of flint and chalk, suggesting the proximity of an ice-sheet of eastern derivation. This ice-sheet apparently stood in the vicinity of Rugby; there, the Upper Wolston Clay is absent, and its place taken by the chalky Oadby Till as at Gibbet Lane Quarry, Shawell (see above).

E. Stretton Wharf–Auger traverse through the Drift succession [SP 4415 8075]

In Section 2 of this guide, two contrasting interpretations of the palaeogeography of Glacial Lake Harrison were discussed. On the hill south of Stretton Wharf (Figure 10), the controversy is addressed by an auger traverse based on recent BGS mapping of a succession which may be transitional between two different provinces of drift deposition. North of here, the drift sequence is that described by Shotton (1953) and Douglas (1980), in which there is a single bed of Wolston Clay representing the deposit of one large lake. To the south, however, glaciolacustrine clays are intercalated with glaciofluvial deposits suggesting that there may have existed a number of small lakes rather than a single large one (Sumbler, 1983).

The four highest drift members at Stretton Wharf comprise a thinned but otherwise typical 'Wolston ' succession which also occurs on the drift plateau farther north (Figure 10) and, as Figure 3 shows, prevails throughout the northern part of the Coventry district (BGS map sheet No. 169). These four members are, from the top of the hill; the *Oadby Till, Wolston Sand and Gravel, Wolston Clay* and *Thrussington Till.* The Wolston Clay is the thinned, feather edge of the single bed, mentioned above, which thickens northwards to around 40m near Hinckley (Figure 3). Shotton (1976) named this bed the 'Bosworth Clays and Silts', and it is here informally termed the 'Bosworth tongue' of the Wolston Clay. The same bed was considered by Rice and Douglas (1991) to be a major development of Glacial Lake Harrison as a single large body of water.

The two lower drift members, augered beneath the Thrussington Till, are part of the more complex sequence noted above to occur south and east of this locality. Beneath the till is a red, silty glaciolacustrine clay with possible admixed till-derived detritus represented by sporadic small stones. This deposit extends southwards (Figure 10), merging with the Wolston Clay mapped in the Warwick district (Old and others, 1987; Sumbler, 1983). The red and orange sand augered beneath this clay is correlated with the bodies of Wolston Sand and Gravel which Sumbler (1983) found intercalated within the Wolston Clay of the Warwick district. Indeed, Figure 10 shows that between the auger traverse and Stretton Under Fosse the Thrussington Till, Wolston Clay and Wolston Sand and Gravel are all interdigitated, with the last-named thickening considerably to the north-east.

We interpret the lower three beds at Stretton Wharf to have been deposited in an environment transitional between a lake basin and the outwash system of a nearby stationary Thrussington Till ice sheet. In such environments, mobilised tills derived from the ice front can become intercalated with proglacial deposits of glaciofluvial or glaciolacustrine origin, giving rise to successions characterised by highly lenticular beds (Edwards 1978). Lacustrine deposition (Wolston Clay) would have been punctuated by glaciofluvial episodes (Wolston sand and Gravel) as outwash fans prograded into the basin, producing the series of transient lakes envisaged in the model of Sumbler (1983).

In contrast, the beds above the Thrussington Till were deposited in a more distal environment following retreat of the ice front and expansion of the glacial lake basin. The early part of this phase was dominated by deposition within a single large lake, forming the upper lacustrine bed in Figure 10, known as the 'Bosworth tongue' of the Wolston Clay. This deposit feathers out towards Stretton Under Fosse, indicating that the lake was impounded by the thick wedge of proglacial deposits formed earlier. After the lake waters had drained away an extensive sandur prograded across its floor, depositing the bed of Wolston Sand and Gravel in the upper part of the augered section. Subsequent re-advance of the ice sheet deposited the Oadby Till which caps the successsion.

The Stretton Wharf succession indicates that the alternative hypotheses of a single large Glacial Lake Harrison, or a series of smaller transient lakes, need not be mutually exclusive; both ideas can be accomodated if the East Midlands drift is viewed as having accumulated within a dynamic depositional province in which environments varied both in space and in time.

Acknowledgements

The cooperation of management and staff of Steetley Quarry Products, now Redlands Plc (Gibbet Lane and Frog Hall Quarries), Acresford Sand and Gravel Ltd. (Huncote Pit) and of Mr. Hewitt of Cloudesley Farm (Stretton Wharf locality) are gratefully acknowledged.

References

AMBROSE, K and BREWSTER, J. 1982. A re-interpretation of parts of the 400ft bench of southeast Warwickshire. *Quaternary Newsletter,* No.36, 21–24.

BISHOP, W W. 1958. The Pleistocene geology and geomorphology of three gaps in the Midland Jurassic escarpment. *Philosophical Transactions of the Royal Society of London,* Series B, Vo1.241, 255–306.

DOUGLAS, T D. 1980. The Quaternary deposits of Western Leicestershire. *Philosophical Transactions of the Royal Society of London.* Series B, Vol. 288, 260–285.

DURY, G H. 1951. A 400-ft bench in south-eastern Warwickshire. *Proceedings of the Geological Association,* Vol.62, 167–173.

EDWARDS, M C. 1978. Glacial environments, 416–438 *in Sedimentary Environments and Facies.* READING, H G (editor) (Oxford: Blackwell Scientific Publications).

FLINT, S and TURNER, P. 1988. Alluvial fan and fan-delta sedimentation in a forearc extensional setting: the Cretaceous Coloso Basin of northern Chile, 387–399 *in Fan Deltas: Sedimentology and Tectonic Settings.* NEMEC, W. and STEEL, R J. (editors) (Blackie and Son).

HOGG, S E. 1982. Sheetfloods, sheetwash, sheetflow, or...? *Earth Science Reviews,* VoL18, 59–76.

KELLY, M R. 1968. Floras of Middle and Upper Pleistocene age from Brandon, Warwickshire. *Philosophical Transactions of the Royal Society of London,* Series B, Vol.254, 401–415.

MITCHELL, G F, PENNY, L F, SHOTTON, F W and WEST, R G. 1973. A correlation of Quaternary deposits in the British Isles. *Geological Society of London Special Report,.* No.4.

OLD, R A, SUMBLER, M G and AMBROSE, K. 1987. Geology of the country around Warwick. *Memoir of the British Geological Survey,* Sheet 184 (England and Wales).

PERRIN, R M S, DAVIES, H and FYSH, M D. 1973. Lithology of the chalky boulder clay. *Nature Physical Science,* Vo1.254, 101–104.

POOLE, E G, WILLIAMS, B J and HAWS, B A. 1968. Geology of the country around Market Harborough. *Memoir of the Geological Survey of Great Britain,* Sheet 170 (England and Wales).

RICE, R J. 1968. The Quaternary deposits of central Leicestershire. *Philosophical Transactions of the Royal Society of London,* Series A, Vol.262, 459–509.

RICE, R J. 1981. The Pleistocene deposits of the area around Croft in south Leicestershire. *Philosophical Transactions of the Royal Society of London,* Series B, Vol.293, 385–418.

RICE, R J, and DOUGLAS, T. 1991. Wolstonian glacial deposits and glaciation in England. 25–35 *in Glacial deposits in Great Britain and Ireland.* EHLERS, J, GIBBARD, P L and ROSE, J. (editors). (Rotterdam/Brookfield: AA Balkema).

SHOTTON, F W. 1953. Pleistocene deposits of the area between Coventry, Rugby, and Leamington, and their bearing on the topographic development of the Midlands. *Philosophical Transactions of the Royal Society, London,* Series B, Vol.237, 209–260.

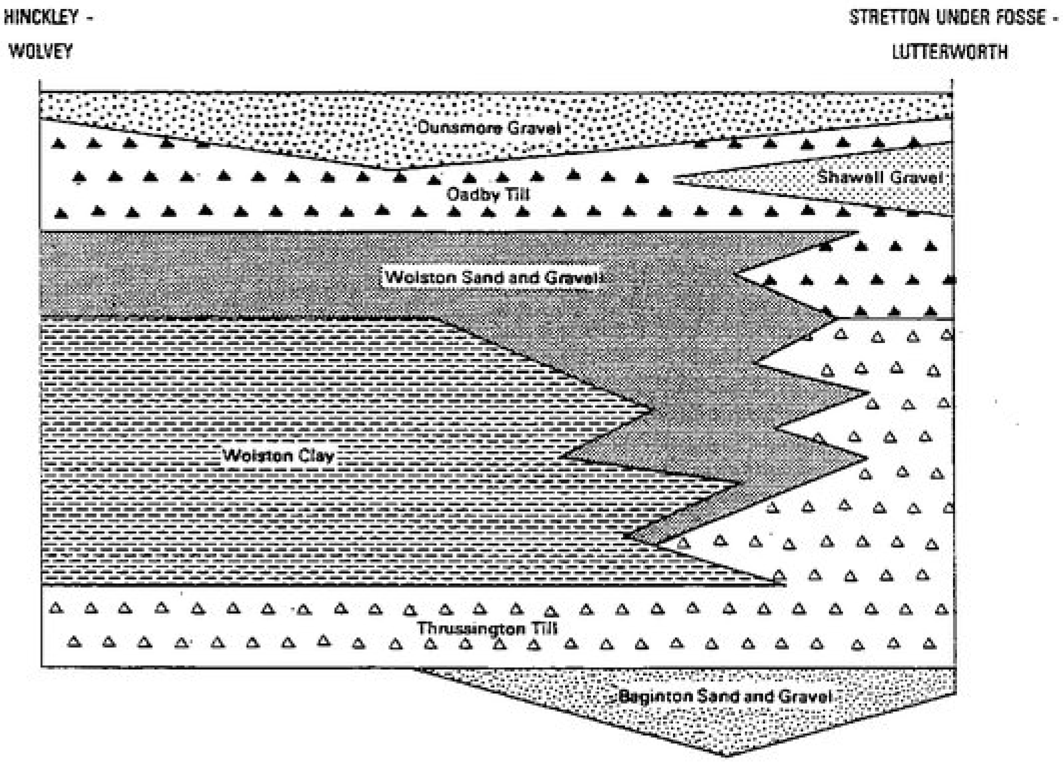
SHOTTON, F W. 1976. Amplification of the Wolstonian stage of the British Pleistocene. *Geological Magazine,* Vol.113, 241–250.

SHOTTON, F W and WEST, R G. 1969. Stratigraphic table of the British quaternary. 155–157 *in* Recommendations on a stratigraphic usage. *Proceedings of the Geological Society of London,* No.1656.

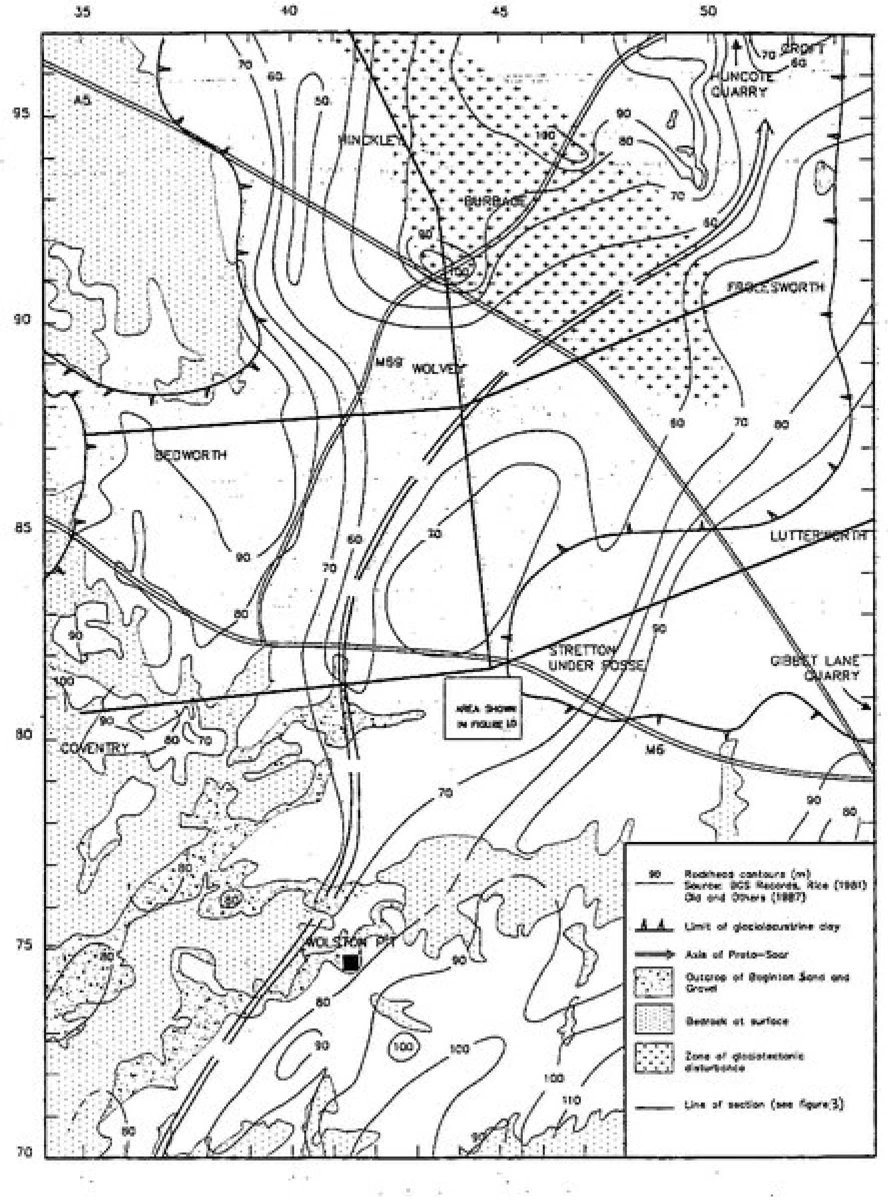
SMITH, N D. 1974. Sedimentology and bar formation in the upper Kicking Horse River, a braided outwash stream. *Journal of Geology,* Vol.82, 205–223.

SUMBLER, M G. 1983. A new look at the type Wolstonian glacial deposits of Central England. *Proceedings of the Geologists Association,* Vol. 94 (1), 23–31.

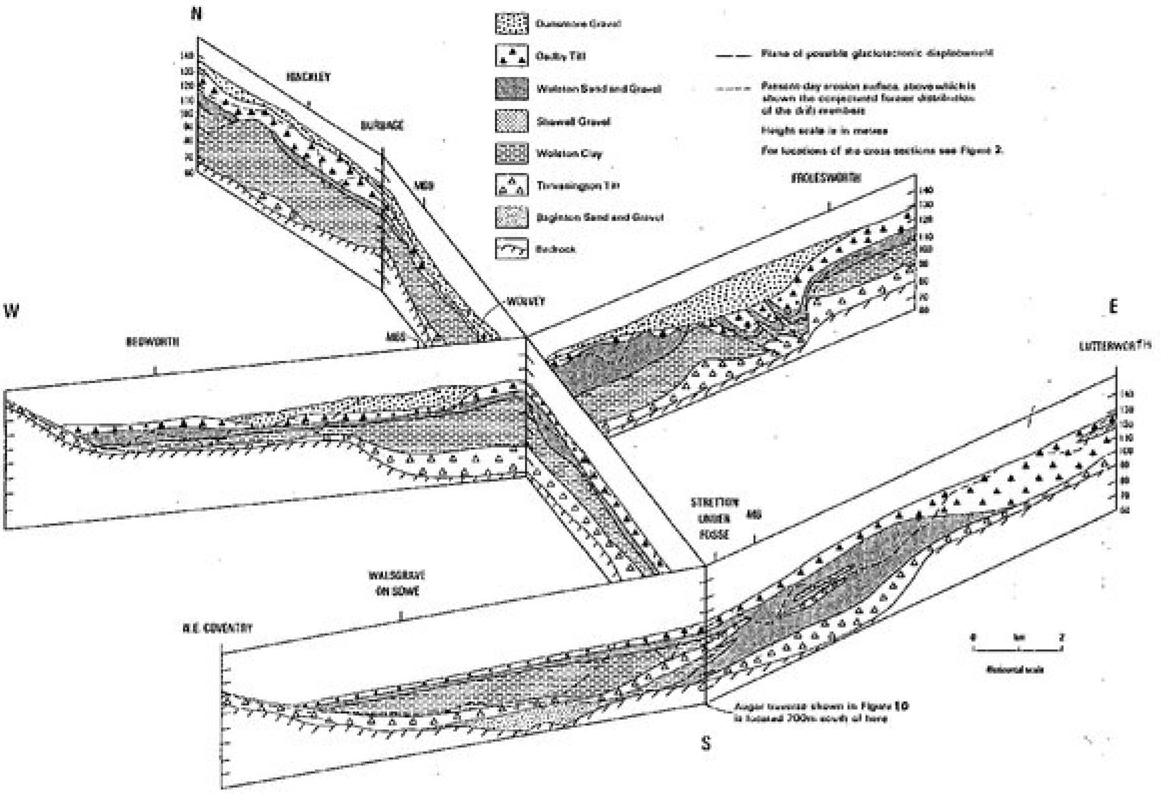
SUMBLER, M G. 1989. The Frog Hall Sand and Gravel: a post-"Wolstonian" fluvial deposit near Coventry. *Quaternary Newsletter articles,* 3–8.



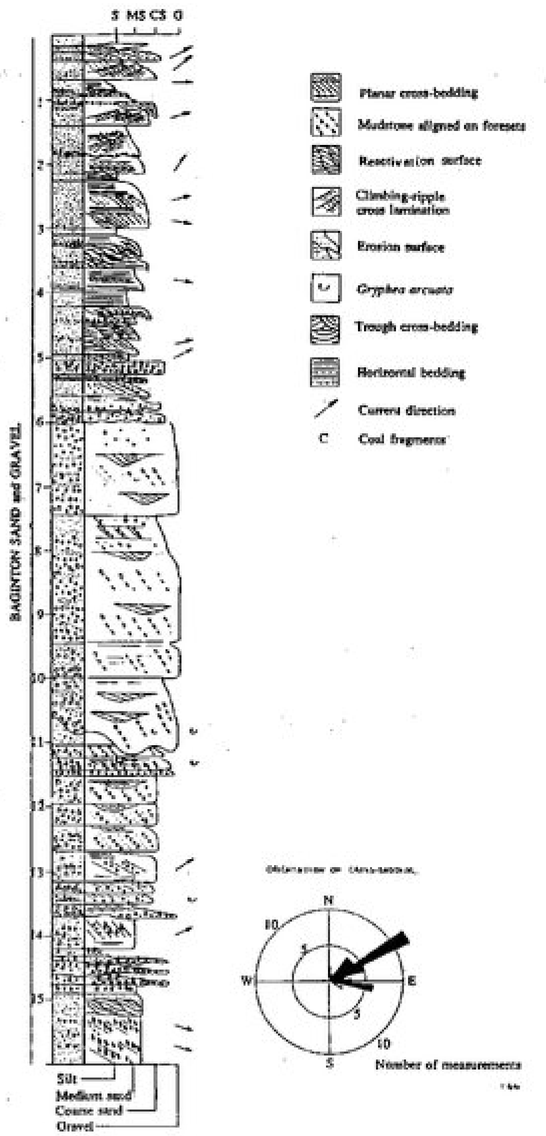
(Figure 1) Summary of stratigraphical relationships in the Drift succession.



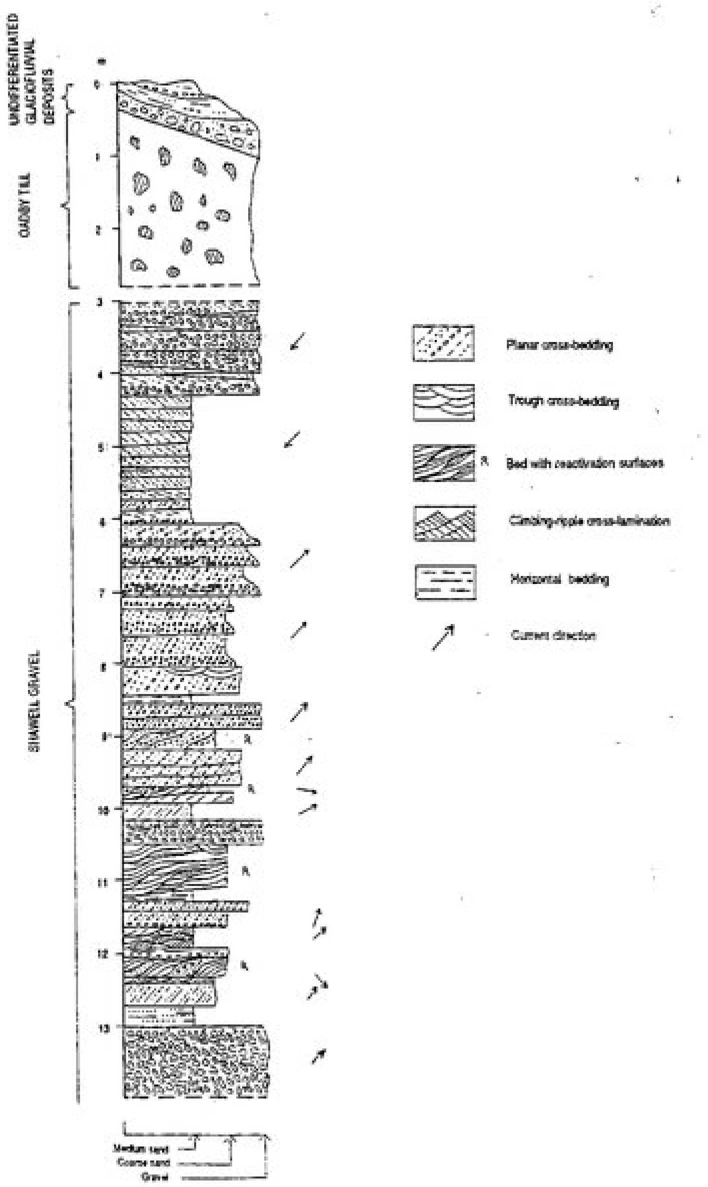
(Figure 2) Geological setting of the East Midlands Drift succession.



(Figure 3) Composite cross sections showing relationships within the Drift deposits in the Coventry district.



(Figure 4) Section in the Baginton Sand and Gravel at Huncote Pit.



(Figure 5) Section in the Shawell Gravel, Oadby Till and 'undifferentiated glaciofluvial deposits' at Gibbet Lane Quarry.

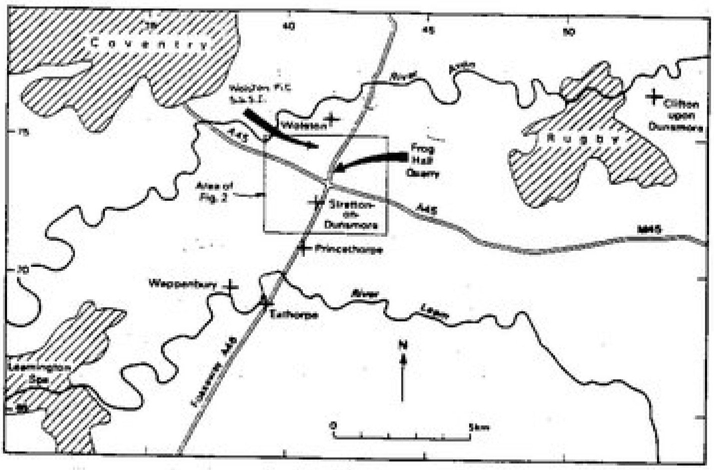


Figure 6 Location of Wolston Pit and Frog Hall Quarry

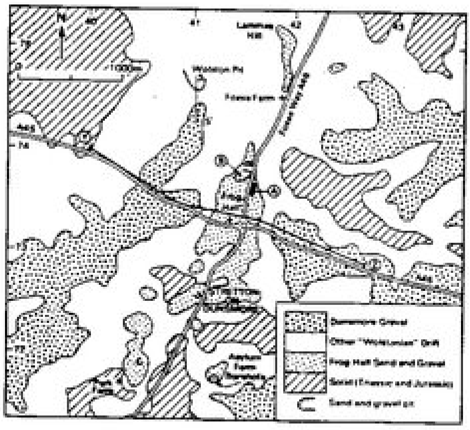
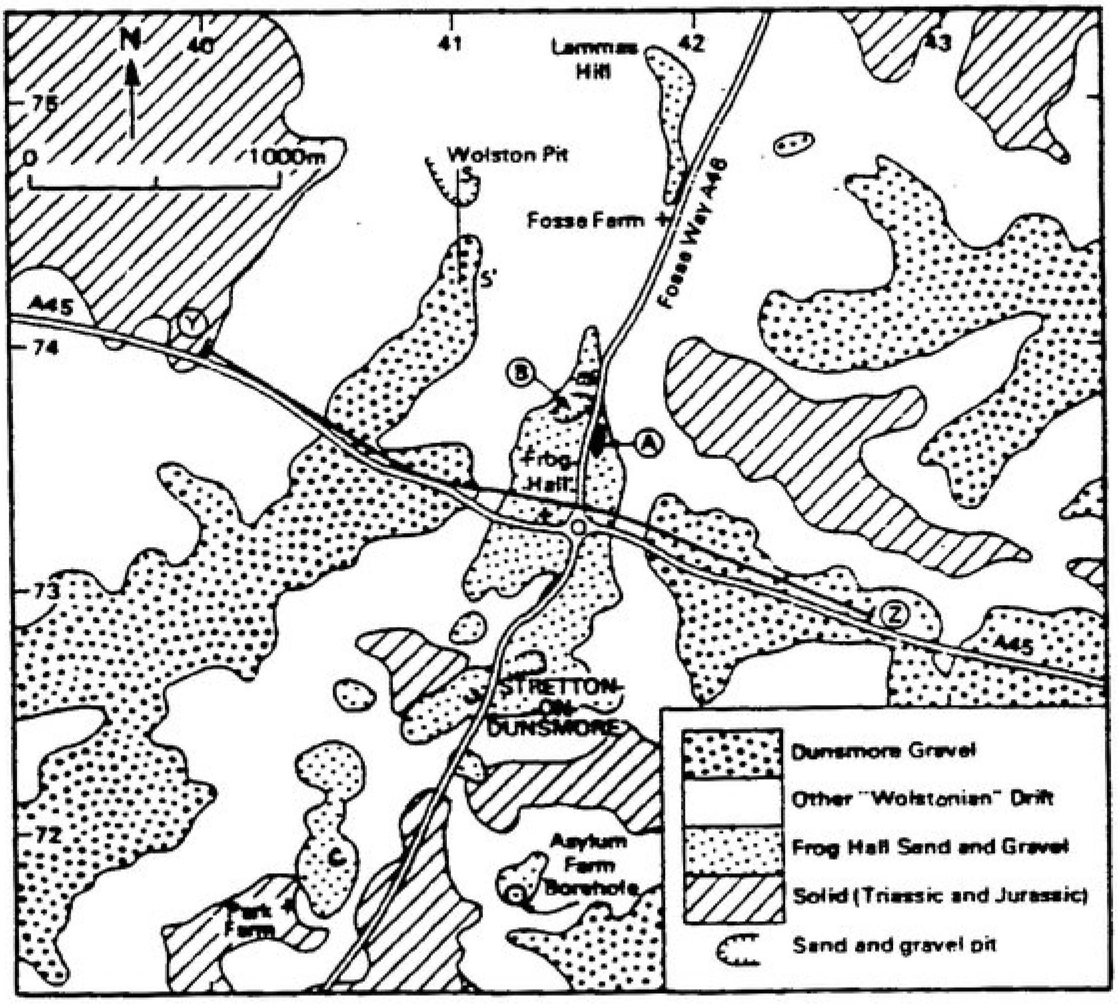
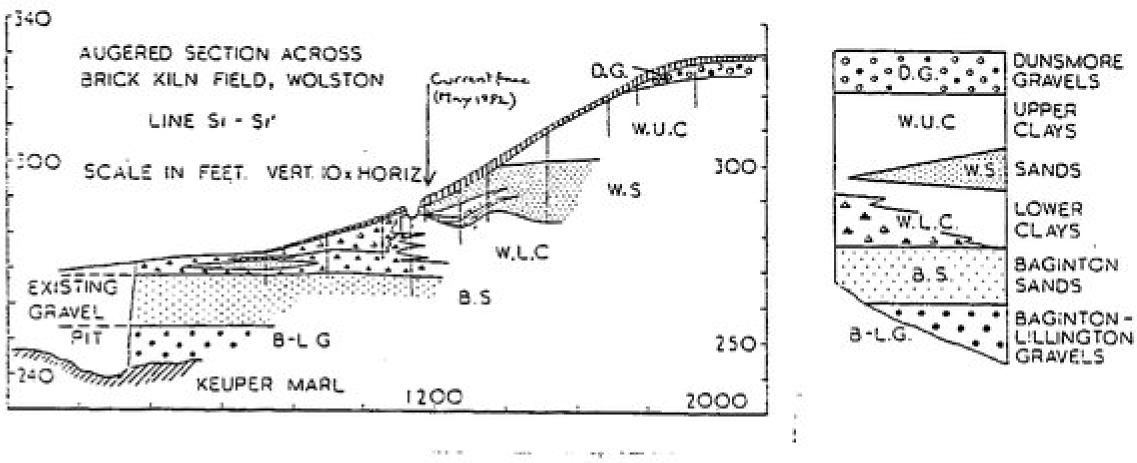


Figure 7 Simplified geological map and location of sections at Wolston Pit and Frog Hall Quarry (see Figures 8 and 9). A = Frog Hall Quarry

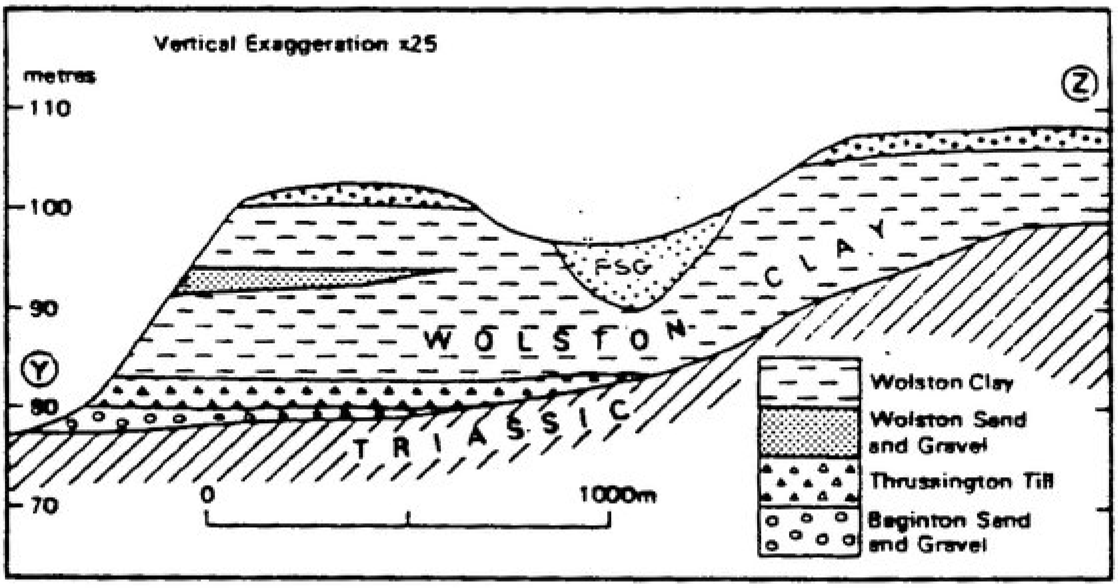
(Figure 6) Location of Wolston Pit and Frog Hall Quarry.



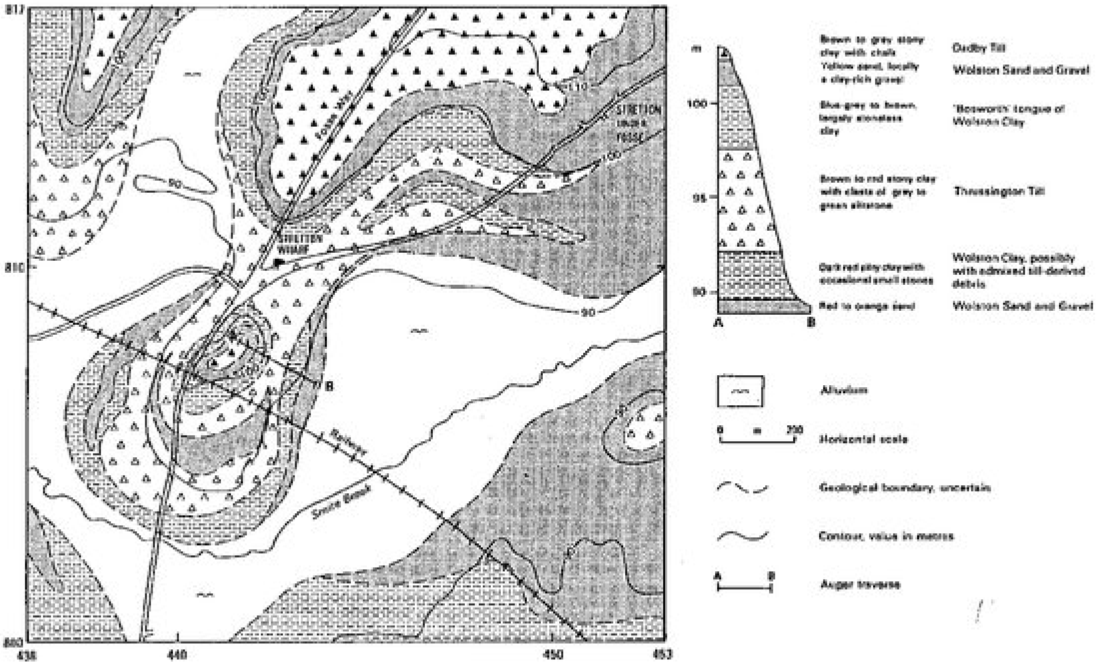
(Figure 7) Simplified geological map and location of sections at Wolston Pit and Frog Hall Quarry see (Figure 8) and (Figure 9). A = Frog Hall Quarry.



(Figure 8) Geology at Wolston Pit (from Shotton, 1953, figure 10); see (Figure 7) for line of section. The lateral position of the extant face is indicated. N.B. the 'boulder clay' included within the Lower Wolston Clay (W.L.C.) is now classified as Thrussington Till.



(Figure 9) Cross-section showing the relationship of the Frog Hall Sand and Gravel (FSG) to the Wolston 'Series' (from Sumbler, 1989, figure 3). Other ornaments as in (Figure 7).



(Figure 10) Locality map of the auger traverse at Stretton Wharf.

Wolston Pit. Wolstonian glacial deposits. Wolston Gravel Pit, now largely backfilled, has been designated the type locality of the Wolstonian stage of the Pleistocene. At the top of the face can be seen the Wolston Sand, partly overlain by loamy hillwash. Beneath are smooth grey and brown clays, representing the Wolston Lake Deposits. The Baginton Sand outcrop is concealed by slipped clay and vegetation. British Geological Survey image: P212262.