

TECHNICAL REPORT WA/88/39

TM 35 NE

Snape

Part of 1:50 000 Sheets 191 (Eye) and

208 (Woodbridge)

J A Zalasiewicz

Natural Environment Research Council
British Geological Survey
Geological Survey of England and Wales
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Geological notes and local details
for 1:10 000 sheet TM 35 NE

Snape

Part of 1:50 000 Sheets 190 (Eye) and
208 (Woodbridge)

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NOTES

1. Most of the colours described in this report were recorded using the Rock-Colour Chart of the Geological Society of America; eg dark yellowish orange (= 10YR 6/6).
2. All the grid references cited in the text lie in 100 km square TM.
3. The selected details include extendable dutch-auger holes and trial pit excavations. Logs of these have been deposited in the BGS 1:10 000 Record System and are numbered accordingly.

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GEOLOGICAL NOTES AND LOCAL DETAILS FOR 1:10 000 SHEET TM 35 NE (SNAPE)

J A Zalasiewicz

1. INTRODUCTION

This report describes the geology of the 1:10 000 sheet TM 35 NE which is included in the Eye (190) and Woodbridge (208) geological maps. The area was first surveyed by W Whitaker and W H Dalton as part of the Old Series One-Inch sheet 50 SE published in 1883. The primary six-inch survey of the Snape area was made by J A Zalasiewicz in 1982-3 under the direction of Dr W A Read as Programme Manager. Uncoloured dyeline copies of the map can be obtained from the British Geological Survey, Keyworth.

The sheet area lies some 10 Km north-east of Woodbridge, Suffolk. Most of the ground is broadly flat and lies at c 20-25 m OD. It is underlain largely by Boulder Clay and given over to arable farming. Boulder Clay is absent from the south-east of the area, where a broad outcrop of Kesgrave Sands and Gravels largely coincides with coniferous forest.

The south-eastwards flowing River Alde and its tributaries have incised wide valleys in the central and northern parts of the area. Kesgrave Sands and Gravels and the underlying Chillesford Sand crop out in the valley sides, together with irregular masses of Fluvio-Glacial Sand and Gravel and Boulder Clay. The wide flat valley floors are underlain by freshwater and estuarine alluvium, and are given over to arable farming with some pasture.

The major settlement is Snape, where The Maltings is now a well-known concert hall. There are two smaller settlements, Tunstall and Blaxhall, and a number of scattered farmsteads.

The geological sequence, with thicknesses and principal lithologies, is shown in Table I.

Table 1 Geological Sequence of the Snape area. (Maximum thicknesses to the nearest metre are derived from boreholes unless otherwise stated)

* Maximum thickness estimated from geological mapping

+ Formations not exposed at surface

| DRIFT DEPOSITS | Quaternary | Flandrian | Alluvium (undifferentiated) | silts and clays with sands and thin peats | up to 5 m* |
|------------------|------------|---------------|---|--|--------------|
| | | Anglian | Tidal Flat Deposits Fluvio-Glacial Sand and Gravel | sands and clays | up to 5 m* |
| | | | Glacial Sand and Gravel | gravels | up to 10 m* |
| | | | Boulder Clay | sands and gravels | up to 5 m* |
| | | | Glacial Silt and Clay | chalk rich silty clay | up to 10 m* |
| | | | | silts and clays | up to 3 m* |
| | | ?Beestonian | Kesgrave Sands and Gravels | pebbly sands and gravels | up to 10 m* |
| SOLID FORMATIONS | | ?Bramertonian | Norwich Crag | | |
| | | | Chillesford sand | sands with silts | up to 15 m* |
| | | Pre-Ludhamian | Red Crag | shelly sands | up to 25 m* |
| | Tertiary | Eocene | London Clay | silty clays | up to 15 m+ |
| | | | Lower London Tertiaries | clays, sandy clays and sands | up to 13 m+ |
| | Cretaceous | | Chalk | fine -grained limestone with flint nodules | about 271 m+ |

2. SOLID FORMATIONS

2.1 CHALK

Chalk is not exposed at surface, though it has been penetrated in two boreholes. The maximum thickness proved is 44.8 m, in a borehole at Blaxhall Hall [3504 5757]. The total thickness of the formation is likely to be near the 271 m proved in a borehole at Harwich, some 25 km to the south-south-west of the sheet area. Regionally, the top of the Chalk dips eastwards at less than 1° . Within the sheet area the top of the Chalk descends from -20 m OD in the west, to very approximately -70 m OD in the east. The Chalk is Upper Cretaceous in age.

2.2 LOWER LONDON TERTIARIES

These are not exposed at surface, but have been proved in two boreholes (see Appendix A). They are 12-13 m thick and consist of grey, brown and red mottled clays with minor sand beds. They are Palaeocene in age.

2.3 LONDON CLAY

London Clay underlies all of the Plio-Pleistocene deposits of the sheet area, though it is nowhere present at outcrop. It has been proved in two boreholes (see Appendix A), to a maximum thickness of 15 m.

In lithology, it is a dark grey silty clay, commonly fissured and with some hard 'cementstone' bands. It is Eocene in age.

2.4 RED CRAG

The Red Crag underlies all of the sheet area but it has a very limited outcrop. It is largely confined to the lower slopes of the Alde valley south-west of Snape, around [385 577] [379 572] and [388 578].

Also, there is a small outcrop in a tributary of the River Alde, which

extends from just north of Beversham Bridge [358 583] to the western edge of the sheet.

The Red Crag consists of medium and coarse-grained, poorly sorted, shelly sands. Rare small flint, vein quartz and phosphate pebbles are present. Silt and clay grade material is rare and generally takes the form of thin laminae that are heavily encrusted with iron oxides. The deposit is reddish at surface due to the oxidation of iron-bearing minerals. At depth it is commonly grey-green and unoxidized. The shell material largely comprises comminuted and broken molluscan valves. The upper few metres are generally decalcified.

The junction of the Red Crag and the overlying Chillesford Sand is commonly difficult to locate precisely because coarse, medium and fine sand are interbedded. The boundary has been drawn to reflect the dominant lithology.

The Red Crag of the sheet area is probably characterised by 'Butleyan' molluscan faunas (Harmer, 1900, 1902). In the presently accepted stage system (Mitchell *et al.*, 1973), the Red Crag is assigned to the Pre-Ludhamian Stage. In Mitchell *et al.*, (1973) the Pre-Ludhamian is referred to the basal Pleistocene; however, more recent work (Curry *et al.*, 1978) has indicated that part of it may belong to the Pliocene.

The Red Crag is regarded by Boatman (1976) and Dixon (1979) as having been deposited in a shallow, tidal, marine environment.

Selected Details

Extendable dutch-auger hole (TM 35NE/11):
[3781 5722]

0-1.20 m Soil and wash

1.20 - 2.50 m Red Crag; sand, dark yellowish orange becoming dark reddish brown downwards, coarse to fine-grained, poorly sorted, with slight fines bind in places; from 1.90 some indications of banding on a 1-3 cm scale, picked out by slight variations in colour and grain size.

Extendable dutch-auger hole (TM 35 NE/36)

[3561 5829]

0 - 0.40 m Soil

0.40 - 3.00 m Chillesford Sand; sand, fine-grained, well sorted; fine to medium-grained, poorly sorted in part below 2.00.

3.00 - 3.85 m Red Crag; sand, brown and yellow, coarse to fine-grained, very poorly sorted; some comminuted shell debris; iron-cemented clay pan at 3.85.

2.5 NORWICH CRAG

The Norwich Crag Formation of south-east Suffolk has been subdivided into two members, the Chillesford Sand and the Chillesford Clay (Zalasiewicz and Mathers, 1985). Only the Chillesford Sand is present within the sheet area.

2.5.1 CHILLESFORD SAND

The Chillesford Sand is widely distributed in the sheet area, cropping out in the sides of all the major valleys. It is equivalent to the Chillesford Sand of Prestwich (1871) and Harmer (1900, 1902).

The Chillesford Sand of the sheet area is 10-15 m thick. Characteristically, it consists of unfossiliferous fine to medium-grained, well sorted sand. Poorly sorted silty layers occur, and scattered silt/clay laminae are present in places. Sedimentary structures include horizontal bedding and burrows. Coarser layers are commonly present near the junction with the Red Crag.

The Chillesford Sand is a shallow marine deposit of Pleistocene age. Pollen spectra, foraminifera and molluscs from this unit in adjacent areas, originally taken to indicate the Pastonian Stage (West and Norton, 1974), were subsequently assigned to the Bramertonian Stage (Funnell, Norton and West, 1979).

Selected Details

Hill Farm; [3626 5876]

Section in old pit.

0 - 0.60 m Soil and wash

0.60 - 1.60 m Chillesford Sand; sand, orange-yellow, fine-grained, well sorted; generally structureless, but a few irregular lenses of light brown, fine-grained, poorly sorted, silty sand are present; these are sharply bounded at top and base.

Racewalk Covert; [3762 5930]

Section in old pit.

0 - 1.50 m Glacial Sand and Gravel; gravel, coarse, chalky

1.50 - 2.50 m Chillesford Sand; sand, pale yellow and grey, fine-grained, very well sorted, with faint horizontal planar to slightly wavy lamination; laminae 10 - 20 mm thick.

Blaxhall Common; [3788 5700]

Section in old pit

0 - 0.50 m Soil and wash

0.50 - 0.90 m Kesgrave Sands and Gravels; sand, gravelly

0.90 - 1.90 m Chillesford Sand; sand, pale yellow and grey, fine to medium-grained, well sorted; no sedimentary structures seen.

Extendable dutch-auger hole [TM 35 SE/19]

[3784 5885]

0 - 0.50 m Soil and wash

0.50 - 4.15 m Chillesford Sand; sand, dark yellowish orange, fine to medium-grained, moderately to well sorted; few scattered silty clay laminae; some silty clay intraclasts.

Extendable dutch-auger hole [TM 35 NE/52]
[3975 5632]

0 - 0.40 m Soil

0.40 - 1.50 m Chillesford Sand; sand, fine to medium-grained, well sorted to poorly sorted and silty; scattered silt/clay laminae

1.50 - 1.90 m Chillesford Sand; sand, fine, interlaminated with silty clay

1.90 - 3.70 m Chillesford Sand; sand, fine to medium-grained, moderately sorted, with scattered silty clay laminae

3.70 - 4.20 m Red Crag; sand, coarse to fine-grained, poorly sorted; banding on 2-5 cm scale shown by slight variations in grain size and sorting.

3. DRIFT DEPOSITS

3.1 KESGRAVE SANDS AND GRAVELS

The interfluve in the south-east of the sheet area, around Tunstall Forest, is capped with an extensive thin spread of sands and gravels. This unit is provisionally correlated with the Kesgrave Sands and Gravels of Rose and Allen (1977); it was previously mapped as Glacial Sand and Gravel (Whitaker and Dalton, 1883). The Kesgrave Sands and Gravels also underlie the glacial deposits over the rest of the area, cropping out in the upper valley sides. In this situation, however, they are likely to have been reworked in part by glacial meltwaters. Hence, some of the deposits mapped as Kesgrave Sands and Gravels may in fact be Glacial Sand and Gravel.

This unit is 3-6 m thick over most of the area; greater thicknesses are probably present in localised scour-hollows. The base of the unit lies around 15 m OD; in the vicinity of some of the major rivers it descends to lower elevations. The upper surface of the unit in the vicinity of Tunstall forest may represent a largely unmodified depositional surface.

The Kesgrave Sands and Gravels consist of unfossiliferous fine to coarse-grained sands, pebbly sands and subordinate gravels. Pebbles in the gravel fraction largely comprise rounded to subangular flints with lesser amounts of rounded to subrounded vein quartz and quartzite. Sedimentary structures include coarsening up units 1-2 m thick.

The Kesgrave Sands and Gravels are regarded by Rose and Allen (1977) as fluviatile braidplain deposits, laid down by a north-eastwards flowing "proto-Thames"; they were provisionally assigned to the Beestonian (cold) Stage. In the Ipswich area, the upper surface of the Kesgrave Sands and Gravels comprises a reddened, clay-enriched palaeosol, the Valley Farm Sol Lessivé, which has been assigned to the Cromerian (temperate) Stage (Rose and Allen, 1977). This palaeosol was not recognised in the sheet area.

LOCAL DETAILS

Blaxhall Common; [3788 5700]

Section in old pit

0 - 0.50 m Soil and wash

0.50 - 0.90 m Kesgrave Sands and Gravels; sand, gravelly; sand yellow-grey, medium to coarse-grained, generally poorly sorted; pebbles include subangular flint, rounded and subrounded quartz and quartzite, generally less than 20 mm diameter; laminated on a cm scale; laminae dip gently to NE; base sharp with gravel lag.

0.90 - 1.90 m Chillesford Sand; sand, fine-grained.

Extendable dutch-auger hole (TM 35 NE/42)

[3805 5580]

0 - 0.100m Soil and wash

1.00 - 4.15 m Kesgrave Sands and Gravels; sand, pale to dark yellowish orange, fine to coarse-grained, generally moderately to poorly sorted, with rare pebbles.

Extendable dutch-auger hole (TM 35 NE/49)

[3904 5581]

0 - 0.90 m Soil and wash

0.90 - 2.95 m Kesgrave Sands and Gravels; sand, fine-grained, moderately sorted; slightly clayey in part; few pebbles at 2.10 - 2.15; base gradational.

2.95 - 3.25 m Kesgrave Sands and Gravels; sand, gravelly, fine to coarse-grained, moderately sorted.

3.20 - 4.20 m Kesgrave Sands and Gravels; fine to medium-grained becoming fine to coarse-grained, moderately sorted; a few scattered pebbles.

3.2 ANGLIAN GLACIAL DEPOSITS

Deposits of the Anglian glaciation are widespread over the sheet area, being absent only from the south-east quarter. They have been subdivided into Glacial Silt and Clay, Boulder Clay and Glacial Sand and Gravel. Boulder Clay covers much of the higher ground, both as part of the regional Anglian till sheet and, in the vicinity of Snape, within a series of glacial channels (Mathers and Zalasiewicz, 1986, (Fig. 1) which are cut into the Kesgrave Sands and Gravels. Irregular outcrops of Glacial Silt and Clay and Glacial Sand and Gravel are present within and adjacent to the major river valleys. The low-lying Fluvio-Glacial Sand and Gravel is provisionally also included within the Anglian deposits.

3.2.1 GLACIAL SILT AND CLAY

Two small outcrops of Glacial Silt and Clay are present on the southern flank of the Alde valley south of Snape, at around [382 572] and [385 570]. They are associated with an outcrop of Fluvio-Glacial Sand and Gravel. The deposit is probably up to 3 m thick and comprises grey silty and slightly silty clay with millimetre-scale lamination in places. It is overlain in part by thin glacial gravels.

A very small (unmappable) outcrop of this deposit is present within the upper part of the channel-fill sequence near Snape Hall [3933 5910].

Local Details

Extendable dutch-auger hole (TM 35 NE/8)
[3828 5714]

0 - 0.40 m Soil

0.40 - 0.90 m Glacial Sand and Gravel; sand, gravelly

0.90 - 1.10 m Boulder Clay; clay, chalky, interlaminated with poorly sorted fine-grained sand.

1.10 - 1.70 m Glacial Sand and Gravel; sand, clayey, with a little gravel.

1.70 - 3.15 m Glacial Silt and Clay; clay, light olive grey becoming medium grey downwards, slightly silty, faintly laminated; silty from 2.50, with lamination on a millimetre scale and very rare pebbles (?dropstones).

Extendable dutch-auger hole [TM 35 NE/44]
[3933 5910]

0 - 0.80 m Soil and wash

0.80 - 2.15 m Glacial Silt and Clay; clay, light olive grey, dusky

yellow in part; rare isolated pebbles of chalk and flint; deposit apparently un laminated.

2.15 - 2.30 m Glacial Sand and Gravel; sand, fine-grained, clayey.

2.85 - 3.50 m Boulder Clay

3.2.2 BOULDER CLAY

Boulder Clay is present in three situations within the sheet area. Firstly, it occurs as an irregular sheet on the higher ground over most of the area, most commonly at around 17 - 25 m OD. The largest outcrop of this type covers ground four square kilometres north of Tunstall, in the south-western quarter of the sheet. The Boulder Clay is this irregular sheet is generally up to 5 m thick; geophysical studies indicate that locally it may be up to 10 m thick. Secondly, Boulder Clay is present as the upper parts of the infills of a series of east-west trending channels (Fig. 1). These channels are present to the south of Snape, between [TM 387 593] and [TM 400 588]. Boulder Clay in these is up to 5 m thick. Thirdly, Boulder Clay is present as irregular outcrops on the lower slopes and floors of the major valleys around [TM 354 584], [TM 374 576] and [TM 388 569]. They are generally associated with outcrops of Fluvi-Glacial Sand and Gravel. The deposit here is probably less than 5 m thick.

Boulder Clay is a chalk-rich diamicton. Numerous clasts of chalk and flint, with lesser amounts of quartz, quartzite and other lithologies are present in a sandy silty clay matrix. It is generally structureless, though locally near its base it is interbanded with fine sands and silts. It is commonly decalcified near the surface.

The Boulder Clay of the sheet area appears to be lithologically identical to the Lowestoft Till that covers much of East Anglia (Perrin, Rose and Davies, 1979).

Local Details

Extendable dutch-auger hole (TM 35 NE/39)

[3504 555]

0 - 0.50 m Soil and wash

0.50 - 3.60 m Boulder Clay; clay, light olive brown, sandy and silty, with numerous chalk pellets and fragments; some angular to subangular flint pebbles to 30 mm diameter; matrix in places is very chalky, light coloured and friable; rare sand wisps below 2.50.

Extendable dutch-auger hole (TM 35 NE/56)

[3981 5879]

0 - 1.10 m Soil and wash

1.10 - 1.20 m Boulder Clay, decalcified; clay, dusky yellow to light olive brown; very sandy; a few flint pebbles.

1.20 - 1.25 m Boulder Clay; clay, light olive brown to yellowish grey; silty and slightly sandy; numerous chalk grains and pebbles.

1.25 - 1.30 m Glacial Sand and Gravel; sand, fine to medium-grained.

1.30 - 4.20 m Boulder Clay; clay, light olive brown becoming light grey and then dark grey downwards; silty and slightly sandy with numerous chalk grains and pebbles, and some flint pebbles.

3.2.3 GLACIAL SAND AND GRAVEL

Lenses of chalk sand and gravel are associated with Boulder Clay. The largest mappable outcrop is at Blaxhall [362 573]. Smaller outcrops were mapped west of Snape at [371 599] and [376 593]. In addition, Glacial Sand and Gravel is consistently present infilling the lower parts of small east-west trending glacial channels around Snape (see section 4.2.2 above).

The deposits are probably up to 5 m thick. They characteristically show rapid lateral and vertical variations in grain size, from fine sand to coarse chalk-rich gravel. Where decalcified, they cannot be easily distinguished from Kesgrave Sands and Gravels or Fluvio-Glacial Sand and Gravel. Consequently, the outcrop of these deposits is likely to be more extensive than is shown on the face of the map.

Local Details

Blaxhall; [3625 5724]

Section in old pit.

0 - 0.70 m Soil and wash

0.70 - 2.20 m Glacial Sand and Gravel; gravel and sand, mostly coarse and extremely poorly sorted; chalky in part.

Racewalk Covert, West of Snape; [3760 5930]

Section in old pit.

0 - 1.50 m Glacial Sand and Gravel; gravel, sandy; clasts dominantly angular to subangular, but include battered nodular flints to 100 mm diameter in very clayey, chalky, fine to coarse-grained, poorly sorted sand matrix.

1.50 - 2.50 m Chillesford Sand.

Trial pit section; Snape Hall (TM 35 NE/65) [3934 5913]

0 - 0.90 m Soil and wash

0.90 - 1.25 m Boulder Clay, weathered and decalcified

1.25 - 1.75 m Boulder Clay

1.75 - 2.25 m Glacial Sand and Gravel; silt, sandy, with rare chalk and flint pebbles (? dropstones); base gradational.

2.25 - 2.50 m Glacial Sand and Gravel; sand, very pale orange mottled with light brown; fine-grained, well sorted, with scattered pebbles; gravel layer at 2.30 with angular and nodular flints to 110 mm.

2.50 - 2.70 m Glacial Sand and Gravel; sand, pebbly, colour as above; coarse to fine-grained, poorly sorted; pebbles include chalk, rounded to angular flints and sub-rounded quartz to 20 mm diameter; cross-bedded, with foreset laminae dipping 30° at N094°.

2.70 - 2.80 m Glacial Sand and Gravel; gravel, with angular and battered nodular flint pebbles and cobbles to 120 mm diameter.

3.2.4 FLUVIO-GLACIAL SAND AND GRAVEL

Extensive spreads of gravel are scattered on the floor and flanks of the R Alde valley and its tributaries. The outcrops commonly take the form of approximately flat or gently convex ground at around 5 m OD, which may comprise degraded terrace remnants in part. Elsewhere, as on the western flank of a tributary of the River Alde between [359 584] and [357 599], they take the form of irregular spreads at elevations of 5 - 15 m OD.

The deposits are probably up to 5m thick. They consist of sand and flint-rich gravels. The soil cover is characterised by scattered flint pebbles and cobbles. The presence of battered nodular flints and, locally, an association with outcrops of Boulder Clay or Glacial Silt and Clay, indicate that these deposits are probably Anglian in age. However, they probably post-date the main phase of glacial sedimentation.

Local details

Extendable dutch-auger hole; (TM 35 NE/26)
[3936 5726]

0 - 1.00 m Soil and wash

1.00 - 2.00 m Fluvio-Glacial Sand and Gravel; sand, dark yellowish orange, fine-grained, moderately to poorly sorted, with a fines bind; becomes coarser and poorly sorted downwards, with scattered pebbles; base sharp.

2.00 - 2.80 m Fluvio-Glacial Sand and Gravel; sand, pale yellowish orange, fine to medium-grained, well sorted; becomes coarse to fine-grained downwards; scattered pebbles, gravelly at base.

Extendable dutch-auger hole; (TM 35 NE/32)

[3543 5974]

0 - 0.50 m Soil and wash

0.50 - 2.30 m Fluvio-Glacial Sand and Gravel; sand, greyish orange, fine to medium-grained, moderately sorted, with a few scattered pebbles; gravelly at base.

3.3 TIDAL FLAT DEPOSITS

These are presently accumulating on the banks of the River Alde, south of Snape. The deposits consist of sand and clay and are probably up to 5 m thick.

3.4 ALLUVIUM

The floor of the Alde valley and its tributaries is underlain by freshwater and estuarine alluvium, which is probably up to 5 m thick. The estuarine alluvium is present in the eastern (tidal) part of the Alde valley.

The deposits consist of peat and clay, laid down during the Flandrian rise in sea level. Deposition probably commenced around 8500 BP (Carr and Baker, 1968).

APPENDIX A

ABBREVIATED LOGS OF SELECTED BOREHOLES

TM 35 NE/1

[3672 5650]

c 20 m above OD

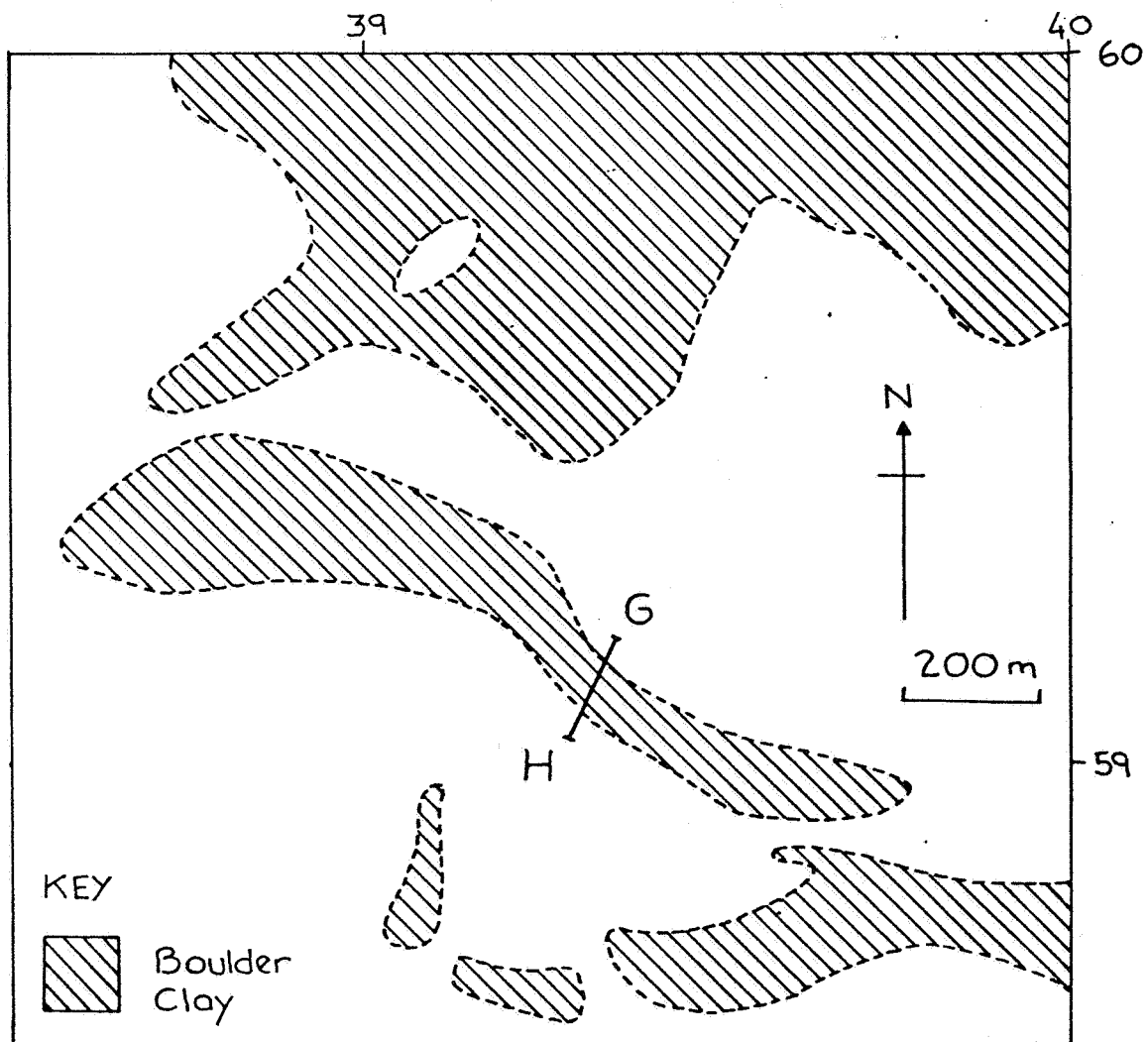
| | Thickness (m) | Depth (m) |
|---|------------------|--------------|
| <u>Quaternary</u> | | |
| Boulder Clay | 4.5 | 4.5 |
| <u>Quaternary and ?Pliocene</u> | | |
| Red and Norwich Craggs | | |
| Sand | 14.5 | 19.0 |
| Sand, shelly | 14.0 | 33.0 |
| <u>Eocene</u> | | |
| London Clay | | |
| Clay, grey, with some calcareous nodules and scattered sand layers | 13.5 | 46.5 |
| <u>Palaeocene</u> | | |
| Lower London Tertiaries | | |
| Clay, grey | 12.0 | 58.5 |
| <u>Cretaceous</u> | | |
| Chalk | 6.5 | 65.0 |

TM 35 NE/2

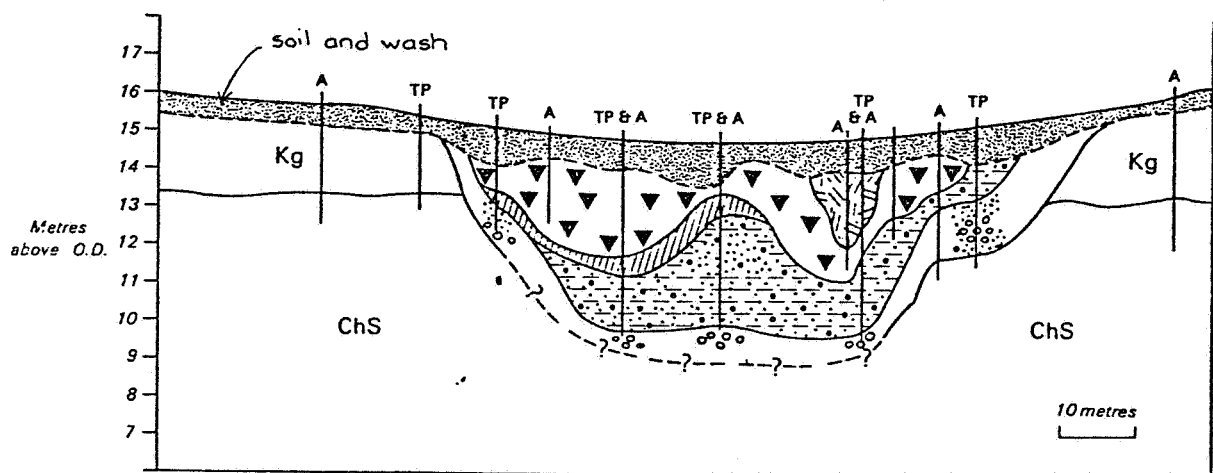
[3504 5757]

c 10.6 m above OD

| | Thickness (m) | Depth (m) |
|---------------------------------|------------------|--------------|
| <u>Quaternary and ?Pliocene</u> | | |
| Red and Norwich Craggs | 9.6 | 9.6 |
| <u>Eocene</u> | | |
| London Clay | 9.1 | 18.7 |
| <u>Palaeocene</u> | | |
| Lower London Tertiaries | | |
| Sand and mottled clay | 12.7 | 31.4 |
| <u>Cretaceous</u> | | |
| Upper Chalk | 44.8 | 76.2 |



G H








- | | | | |
|---|--|---|----------------------------|
|  | Glacial Silt and Clay |  | Glacial Sand and Gravel |
|  | Boulder Clay | Kg | Kesgrave Sands and Gravels |
|  | Boulder Clay interlaminated with underlying deposits | ChS | Chillesford Sand |
|  | Silty sands with dropstones | TP = trial pit ; A = auger hole | |

Fig. 1 Section through glacial deposits infilling a meltwater channel.

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