# Sewerby

[TA 198 683]

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## Introduction

The cliffs at Sewerby, a village to the north of Bridlington on the east Yorkshire coast (Figure 4.25), comprise a sequence of sediments containing evidence of environmental changes since the last interglacial and possibly longer. The exposure lies in the lee of a buried chalk cliff, which is capped to the north by hummocky topography of the 'Flamborough Head moraine' (Lamplugh, 1891a; Farrington and Mitchell, 1951), although most of the exposure is permanently obscured by landslide debris. First reported by Reid (1885) and then investigated more thoroughly by G.W. Lamplugh (1887, 1889, 1891b), the site is of national and international significance owing to: (a) the occurrence of beach deposits dating to the Ipswichian Interglacial of 132–122 ka; (b) a sequence of overlying sediments that document the fall in sea level and decline in temperatures at the beginning of the last (Devensian) glacial cycle; and (c) evidence of the advance of ice into the area during the Dimlington Stadial (Catt and Penny, 1966; Can, 1987b, c). Of further importance with respect to long-term sea-level changes is the buried chalk cliffline and associated marine platform (Figure 4.26), which has been traced from Sewerby (where the modern cliff intersects the buried cliff) inland to Great Driffield and then southwards to the Humber estuary (Crofts, 1906; Crofts and Kendall, in Kendall and Wroot, 1924; Newton, 1925; Valentin, 1957).

Some uncertainty surrounds the stratigraphical relationship between the interglacial beach deposits and the lowest and oldest glacial deposit, the Basement Till, in the Sewerby exposure. Lamplugh (1890) originally documented the interglacial beach to lie below the Basement Till but this was later reassessed by Catt and Penny (1966), who suggested that the beach lay between the Basement Till and the overlying Devensian deposits. This implied that the Basement Till documented a pre-Ipswichian glacia tion. A more recent study by Eyles *et al.,* (1994) has re-instated Lamplugh's original interpretation, suggesting that both the Basement Till and the overlying glacial sediments are post-Ipswichian in age and that the tills and their associated intervening stratified sediments record surging by the North Sea lobe of the British Ice Sheet. Eyles *et al.,* (1994) also reinterpreted the Sewerby gravels, originally regarded as proglacial outwash (Lamplugh, 1884a, 1887; Catt, 1987c), as raised beach deposits dating to deglaciation.

## Description

The buried marine cliff and platform at Sewerby (Figure 4.27) are cut into the dip slope of the Chalk, with the platform dipping away from the cliff at a gradient of between 2 and 3 m $km^{-1}$. The platform is also incised up to 40 m below present sea level by narrow channels, which were cut rapidly in response to falling sea level at the onset of subsequent glaciation (Crofts and Kendall, in Kendall and Wroot, 1924; Valentin, 1957).

The complex till classification scheme that has arisen for east Yorkshire over the last century or more is reviewed in the Dimlington GCR site report (Chapter 5). The lowest and oldest till at Sewerby, the Basement Till (Lamplugh, 1881a, 1882, 1884a, 1890), is only temporarily exposed at a few localities along the Holderness coast, the most extensive exposure being at Dimlington. Described by Bisat (1939, 1940) as the 'Basement Clay', it is part of the Basement Series of Catt and Penny (1966) and comprises a clay-rich, matrix-supported diamicton of a dark grey-brown colour, with green tinges and rafts and smudges of shelly, glauconitic sand. Carruthers (1948) thought these inclusions to be of Bridlington Crag, which includes dinoflagellates and derived pollen indicating a Pastonian age, >1600 ka (Lamplugh, 1884b; Catt and Penny, 1966; Reid and Downie, 1973; Gibbard *et al.,* 1991). Based upon borehole evidence collected by Lamplugh (1919), Catt and Penny (1966) suggest that the Basement Series is the lowest stratigraphical unit on the east Yorkshire coast, directly overlying the chalk platform. A minimum age of 18 000 years BP for the Basement Till is provided by radiocarbon dates on peat overlying the till at Dimlington (Penny *et al.,* 1969). Temporary exposures on the foreshore at Sewerby, reported by Catt and Penny (1966), revealed weathered Basement Till overlain by chalk gravels similar to the

Ipswichian beach gravels (Figure 4.28). This prompted Catt and Penny (1966) and Catt (1987c) to suggest a pre-Ipswichian age for the Basement Till.

The interglacial beach at Sewerby is up to 1.5 m thick and comprises rounded chalk pebbles with occasional flints and erratic lithologies (Figure 4.28). It contains marine molluscs and a relatively rich faunal assemblage (Table 4.9), including straight-tusked elephant (*Palaeoloxodon antiquus*) and hippopotamus (*Hippopotamus amphibius;* Lamplugh, 1891a; Boylan, 1967). Some of these species persist through the two overlying sedimentary units, although hippopotamus is found only within the beach deposit.

Overlying the beach and banked up against the buried cliff base is up to 1.5 m of a clay and chalk slope deposit described as 'clayey chalk-wash' by Lamplugh (1887) and 'rainwash' by Cat and Penny (1966). This deposit includes terrestrial molluscs and vertebrate remains ((Table 4.9); Lamplugh, 1891a; Boylan, 1967).

Lying over the 'rainwash' is a sand deposit, referred to as 'blown sand' by Lamplugh (1887) and Catt and Penny (1966), which occurs as a depositional wedge backed up against the buried cliff and thickens to 8 m at the cliff face. Bedding observed within the sand by Lamplugh (1887) dipped towards the cliff. Although the sand is predominantly well sorted it also includes occasional angular chalk clasts. This deposit contains a restricted vertebrate fauna (Table 4.9), all of which occur also in the interglacial beach shingle. An absolute age of 120 840 ± 1 820 years BP has been obtained for the sand by Bateman and Catt (1996), using luminescence dating techniques.

A clast-supported diamicton, comprising angular chalk and flint clasts with minor sand and silt beds and referred to as 'Chalk rubble' by Lamplugh (1887), occurs as a thin drape (<30 cm thick) on the buried cliff top and then thickens to a maximum of 6 m in a south-westerly direction beyond the former cliff line. This deposit contains cold-climate terrestrial molluscs as reported by Lamplugh (1903). The silt beds possess a similar minerological signature to silts within the overlying Drab–Skipsea Till and have been equated by Catt *et al.,* (1974) with a similar deposit beneath Skipsea Till near Hull, which was later dated to 17 500 ± 1600 years BP by Wintle and Catt (1985).

The upper and most recent till at Sewerby, the Drab Till (referred to more recently as the Skipsea Till by Madgett and Catt (1978) and the Skipsea Till Formation by Evans *et al.* (1995)), is the most extensive glacial deposit on the east Yorkshire coast. It is a matrix-supported diamicton of variable structure and colour, but is predominantly dark greyish-brown with localized streaks of chalk, red sandstone and black shale, the general appearance ranging from massive and structureless to laminated with recognizable fold structures (Eyles *et al.,* 1994; Evans *et al.,* 1995). The colour differences reflect the various source areas of the erratics transported by the North Sea lobe of the British Ice Sheet after its component ice-streams travelled down the Tees valley and along the north-east English coast from Scotland and then over the marine sediments of the North Sea Basin before overriding the chalk and limestone on the Yorkshire coast (Catt and Penny, 1966; Madgett and Catt, 1978; Edwards, 1981; Catt, 1991b). The Skipsea Till also contains numerous sand and gravel lenses, which are either *in situ* (intraformational) and possess concave-up lower boundaries and flat upper boundaries, or are heavily folded and faulted and in places attenuated into smudges (Evans *et al.,* 1995; Benn and Evans, 1996).

(Table 4.9) Faunal list for the Sewerby sedimentary units (after Lamplugh, 1891b; Boylan, 1967; Catt, 1987c).

| | **Ipswichian beach gravel** | **Colluvium** | **Aeolian dune sand** |
|---|---|---|---|
| **Mammalia** | | | |
| *Crocuta crocuta* (hyaena) | • | | • |
| *Ursus (bear*) | | • | |
| *Palaeoloxodon antiquus* (straight-tusked elephant) | | | • |
| *Didermoceros hemitoechus* (narrow-nosed rhinoceras) | • | | • |
| *Hippopotamus amphibius* (hippopotamus) | • | | |

| | | | |
|---|---|---|---|
| *Megaloceros giganteus* (giant deer) | | • | |
| *Bison* cf. *Priscus* (bison) | • | • | • |
| *Arvicola terrestris* (water vole) | | • | |
| **Mollusca** | | | |
| *Littorina littorea* L. | • | | |
| *Ostrea edulis* L. | • | | |
| *Mytilus edulis* L. | • | | |
| *Purpura lapillus* L. | • | | |
| *Pholas* sp. | • | | |
| *Saxicava* sp. | • | | |
| *Helix hispida* L. | | • | |
| *Helix pulchella* Mull | | • | |
| *Pupa marginata* Drap. | | • | |
| *Zua subcyclindrica* L. | | • | |

The stratigraphical exposure at Sewerby is capped by an extensive gravel unit comprising horizontally bedded, massive and imbricated clasts with predominantly discoid and oblate shapes (Eyles *et al.,* 1994). Named the 'Sewerby Gravels' by Dakyns (1879, 1880), Lamplugh (1884a, 1887) and Catt and Penny (1966), this unit was observed by Lamplugh (1881a) to include freshwater silts and ice-wedge casts at a location now hidden behind the sea wall at Bridlington. Similar laminated silts and ice-wedge pseudomorphs have been reported from a coarsening upwards sequence of sediments overlying the Skipsea Till at Barmston (Bridger, 1977; Evans *et al.,* 1995), which are regarded as correlative with the Sewerby Gravels by Eyles *et al., (1994).*

## Interpretation

The stratigraphical position and age of the Basement Till has become a controversial issue in the Quaternary geology of east Yorkshire. A post-Ipswichian age was indicated by the stratigraphy of Lamplugh (1890), but short-lived exposures on the foreshore in the early 1960s led Catt and Penny (1966) to conclude that the Basement Till lay under the Ipswichian beach and therefore documented a pre-Ipswichian glacial event. Based upon amino acid ratios on shells in the Basement Till at Dimlington that indicate a Late Devensian age, Eyles *et al.,* (1994) suggest that the lower (Basement) till at Sewerby also must date to the last glaciation. This has implications for the glacial sequence at Dimlington, because the Basement Till there would indicate an initial Devensian glacier advance prior to 18 000 years BP In interpreting the genesis of the Holderness tills, Eyles *et al.,* (1994) have revived the ideas of Lamplugh (1881b, 1911), who suggested that they originated by the subsole deformation of offshore marine muds and may record surging behaviour by the North Sea glacier lobe.

The changing palaeoenvironmental conditions at Sewerby can be reconstructed by using the faunal remains found within the individual sedimentary units (Lamplugh, 1891b; Boylan, 1967). These are particularly valuable in the interglacial beach and the three overlying units deposited before the Skipsea Till glacier advance. The faunal remains enclosed within the beach gravels, particularly elephant and hippopotamus, are clearly interglacial. Hippopotamus is particularly informative, because its occurrence in the British Quaternary stratigraphy is indicative of the Ipswichian Interglacial of 132–122 ka (Oxygen Isotope Stage 5e) (Jones and Keen, 1993). The interglacial fauna continues throughout the overlying 'rainwash' and sand units, indicating the continuation of warm conditions but changing depositional environments.

The 'rainwash' was interpreted by Lamplugh (1888) and Catt and Penny (1966) as a slope deposit produced by gradual erosion of the chalk cliff by overland flow and minor mass movement processes. The deposit has the characteristics typical of colluvium, materials deposited on slopes by a combination of runoff and mass movement. Interdigitation of the col-luvium and the beach gravels indicates that the storm beach was incorporating chalk clasts by the constant erosion of the bedrock cliff during the high sea-level stand of the last (Ipswichian) interglacial. Owing to the fact that colluvium was removed from the cliff base by storm waves during the deposition of the underlying beach gravels, the survival of the

colluvium was interpreted by Lamplugh (1887) and Catt (1987c) as an early stratigraphical indicator of declining sea level. Catt (1987a) further speculated that the colluvium and overlying blown sand equates to Oxygen Isotope Stages 5d-5a.

The banking of sand up against the cliff is interpreted as further firm evidence for the fall in sea level in the region. Lamplugh (1887) suggested that the bedding within the well-sorted sand indicated a wind-blown origin and that the sediment accumulated as a dune, initially in front of the cliff and later overtopping it. Further analyses by Catt *et al.* (1974) verified an aeolian origin. The dominance of aeolian processes at this time is also indicated by the polished surface of the chalk cliff face, which Lamplugh (1887) interpreted as the product of sand-blasting. The age of 120 840 ± 1820 years BP reported by Bateman and Catt (1996) lends support to the suggested Ipswichian interglacial age for the underlying beach deposits.

Lamplugh's (1887) 'chalk rubble' is interpreted as a gelifluction deposit produced by slow mass movements in a periglacial climate, as indicated by the angularity of clasts and the cold-climate terrestrial molluscs (Lamplugh, 1903). Silt layers within the rubble are interpreted as loess by Catt *et al.* (1974), who additionally used its mineralogical similarity to the silts in the overlying Skipsea Till to suggest a derivation from the outwash plains in front of the advancing glacier ice. The comparison with silts from a similar deposit near Hull dated at 17 500 years BP, if valid, suggests that there is a 100 000 years depositional break between the aeolian dune sands and the gelifluction material (Catt *et al.,* 1974; Catt, 1987c).

The Drab–Skipsea Till records the advance of the North Sea lobe of the last British Ice Sheet, dating to the Dimlington Stadial (see Dimlington site report, Chapter 5). The varied lithologies represented in the erratic suites of the till reveal a complex provenance for the debris load of the ice sheet (Madgett and Catt, 1978). This includes eastern Scottish, northern English and some Scandinavian lithologies, in addition to the offshore muds of Quaternary age and older. Early interpretations by Lamplugh (1911) suggested that the tills of the Yorkshire coast resembled the subglacially deformed sediments observed at modern arctic glaciers prone to surging, but Carruthers (1948) preferred a melt-out origin. Lamplugh's ideas have been reinstated by Eyles *et al.* (1994), who suggest that the extensive glaciotectonic faults and folds and smeared inclusions within the tills document subglacial deformation of pre-existing sediments at the margin of a surging glacier lobe. A deformation origin is also preferred by Evans *et al.* (1995), who interpret the sand and gravel lenses in the Skipsea Till as the products of subglacial meltwater drainage events that punctuated periods of subglacial deformation of pre-existing sediments by the onshore-flowing North Sea glacier lobe. Comprehensive assessments of the Skipsea Till for the whole Yorkshire coast and its implications for former glacier dynamics can be found in Bisat (1939, 1940), Catt and Penny (1966), Madgett and Catt (1978), Catt and Madgett (1981), Boulton and Dobbie (1993), Eyles *et al.* (1994) and Evans *et al.* (1995).

For a long time regarded as the outwash from the receding Dimlington glacier margin (Lamplugh, 1884a; Catt, 1987c), the Sewerby Gravels have recently been re-interpreted as the products of coastal beach processes by Eyles *et al.* (1994). A marine origin was suggested originally by Lamplugh (1884a) and the reconciliation of fluvial versus marine interpretations of other sand and gravel deposits along the Yorkshire coast has remained problematic. If the Sewerby Gravels are marine beach deposits, they document a glacio-isostatically higher sea level during glacier recession. The fact that the North Sea lobe would have glacio-isostatically depressed the crust is incontrovertible, but the penetration of the sea into this area of the North Sea Basin and the flooding of depressed land surfaces during early deglaciation, when global sea levels were up to 100 m lower, has not been demonstrated by available sea-level records for the region (Lambeck, 1995). Lamplugh (1884a, 1891a) concluded that all of the evidence suggested a glaciofluvial origin for the Sewerby Gravels, probably in deltas deposited at the margins of a proglacial lake dammed on the Holderness coastal plain by the receding ice margin. This implies that the finer-grained sediments that crop out farther south are interpreted as the distal, deep-water equivalents of the Sewerby Gravels. The ice-wedge pseudomorphs that occasionally are exposed in the Sewerby Gravels possibly indicate that permafrost conditions prevailed until well after ice recession from the Yorkshire coast, although alternative interpretations of these structures are tenable (e.g. water-escape pipes). Models of sea-level changes during deglaciation have yet to verify the marine origin of the Sewerby Gravels and no systematic sedimentological investigation has been undertaken on the sediments.

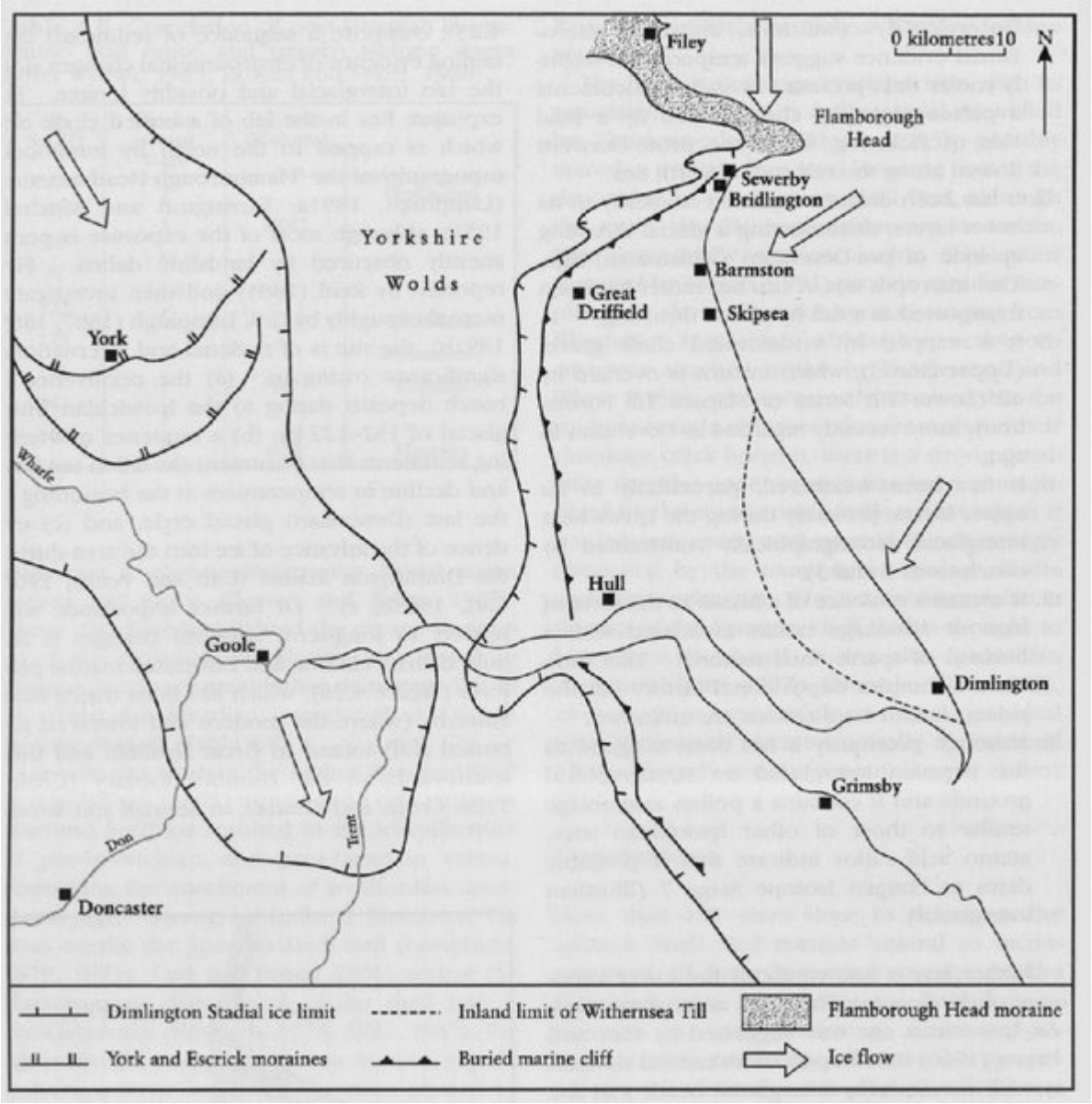
The most recently revised correlation of Quaternary deposits in the British Isles (Bowen, 1999) has renamed most of the sedimentary and stratigraphical units discussed above in order to bring the nomenclature in line with standard lithostratigraphical terminology. The Basement Till is now referred to as the 'Bridlington Member', the Ipswichian beach is called the Sewerby Member, the Skipsea Till is the 'Skipsea Member' and the Sewerby Gravels are the 'Flamborough Member'. These members are all part of the Holderness Formation.

## Conclusions

Sewerby is a site of considerable national and international value with respect to late Quaternary palaeoenvironmental reconstructions and long-term sea-level change. Specifically, the Quaternary sediments are banked up against and drape a buried marine cliff and associated platform that was cut by marine erosion during previous interglacial climate(s). A gravel beach lying on the platform and possibly overlying an older till documents a sea level slightly higher than present. The beach material and two overlying sedimentary units contain faunal remains diagnostic of the last Ipswichian interglacial, dating from 132 to 122 ka. Slope deposits and dune sands overlying the beach gravels record the fall in sea level at the close of the Ipswichian interglacial, when global sea levels were falling in response to the build-up of continental ice sheets. The onset of cold conditions during the Devensian glaciation is recorded by a gelifluction deposit, which drapes the cliff and the earlier sediments. It is thought that a depositional gap of 100 000 years exists between the deposition of the dune sand and the gelifluction deposit. The latter is truncated by the Skipsea Till (Skipsea Member), which was deposited by subglacial deformation by the North Sea lobe of the British Ice Sheet during the Dimlington Stadial, dated to some time after 18 000 years BP There is controversy surrounding the interpretation of the uppermost sedimentary unit, the Sewerby Gravels (Flamborough Member), which has been interpreted as glaciofluvial outwash and marine beach deposits.

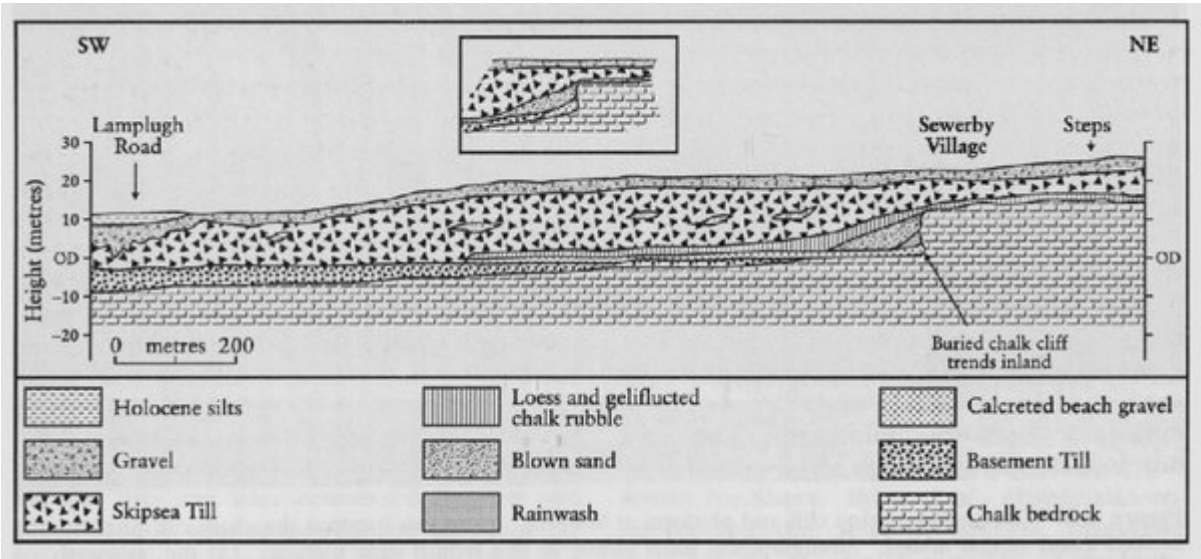
Further critical work is required at Sewerby on two major themes: (a) the stratigraphical position of the Basement Till (Bridlington Member), specifically its relationship with the Ipswichian beach (Sewerby Member), even though the most recent correlation of Quaternary deposits in the British Isles (Bowen, 1999) regards the Basement Till as Late Devensian; and (b) the genesis of the Sewerby Gravels (Flamborough Member) and their significance with respect to the deglacial sea-level history of east Yorkshire.

**References**




*(Figure 4.26) Map of Holderness showing the location of the buried cliffline and other Quaternary landforms.*


*(Figure 4.27) The buried marine cliff and platform at Sewerby. From this location the chalk cliff (outlined by broken lines) trends inland. Stratigraphical units visible in this typical view include: (A) the 'rainwash' or colluvium; (B) the aeolian sand; (C) the chalk rubble; (D) the 'Drab Till' or Skipsea Till Formation; and (E) the Sewerby Gravels. (Photo: J. Rose.)*




*(Figure 4.28) The stratigraphical sequence at Sewerby based upon Lamplugh (1887) and Catt (1987c). An alternative stratigraphical relationship between the Basement Till and the interglacial beach gravels based upon Lamplugh (1890) and most recently preferred by Eyles et al. (1994) is reproduced in the inset.*

| | Ipswichian beach gravel | Colluvium | Aeolian dune sand |
|---|---|---|---|
| **Mammalia** | | | |
| *Crocuta crocuta* (hyaena) | • | | • |
| *Ursus* (bear) | | • | |
| *Palaeoloxodon antiquus* (straight-tusked elephant) | • | | • |
| *Didermoceros hemitoechus* (narrow-nosed rhinoceras) | • | | • |
| *Hippopotamus amphibius* (hippopotamus) | • | | |
| *Megaloceros giganteus* (giant deer) | | • | |
| *Bison* cf. *Priscus* (bison) | • | • | • |
| *Arvicola terrestris* (water vole) | | • | |
| **Mollusca** | | | |
| *Littorina littorea* L. | • | | |
| *Ostrea edulis* L. | • | | |
| *Mytilus edulis* L. | • | | |
| *Purpura lapillus* L. | • | | |
| *Pholas* sp. | • | | |
| *Saxicava* sp. | • | | |
| *Helix hispida* L. | | • | |
| *Helix pulchella* Müll | | • | |
| *Pupa marginata* Drap. | | • | |
| *Zua subcyclindrica* L. | | • | |

*(Table 4.9) Faunal list for the Sewerby sedimentary units (after Lamplugh, 1891b; Boylan, 1967; Catt, 1987c).*