Dimlington

[TA 390 220]

D.J.A. Evans

Introduction

The cliffs undergoing rapid erosion at Dimlington, East Riding of Yorkshire, contain valuable stratigraphical evidence for the dating of the last glaciation of the British Isles, particularly the attainment of the glacial maximum in lowland England. The stratigraphy is best exposed at Dimlington High Land where it comprises Basement Till, which rests on chalk bedrock, overlain by the Dimlington Silts with enclosed organic remains and two late Devensian tills named the 'Skipsea Till' and 'Withernsea Till' (Catt and Penny, 1966; Penny *et al.,* 1969; Catt, 1987b). Radiocarbon dates on the organic remains in the Dimlington Silts provide a maximum age for the overriding of the site by the late Devensian North Sea lobe of the British Ice Sheet, which deposited the Skipsea and Withernsea tills. This has resulted in the adoption of Dimlington as the climatostratigraphical type site and the use of the term Dimlington Stadial' for the late Devensian glacial episode in Britain (Rose, 1985). The time period 26 000–13 000 years BP is similarly referred to as the 'Dimlington Chronozone'.

Description

The glacial deposits of the Holderness coast have received considerable attention over the last 100 years ((Table 5.4); Wood and Rome, 1868; Lamplugh, 1879, 1891a; Bisat, 1932, 1939, 1940; Catt, 1963; Catt and Penny, 1966; Mitchell *et al.,* 1973; Madgett and Catt, 1978; Edwards, 1981; Evans *et al.,* 1995). The terminology used here is that of Madgett and Catt (1978), who identi- fled three tills of differing appearance and erratic content. The sequence at Dimlington lies on a marine platform cut in the chalk some 30–35 m below present beach level (Lamplugh, 1919; Catt and Digby, 1988). The lowest deposit is the Basement Till, also referred to as the 'Basement Clay' by Bisat (1939, 1940; (Table 5.4)), which lies directly on the chalk platform and is characterized by its dominant clay content, dark grey-brown colouring, inclusions of shelly, glauconitic sand and marine clay and erratics from Scotland and Scandinavia, as well as chalk fragments. Specifically, the Basement till comprises:

1. a massive diamicton with evidence of smeared inclusions and fold structures.
2. rafts of marine sediment.

The term 'Basement Series' has been used by Catt and Penny (1966) for this complex suite of deposits. Dimlington contains the most extensive exposure of Basement Till on Holderness, the only other examples being small and infrequently exposed in the Bridlington–Flamborough area.

The Scottish and Scandinavian erratics in the Basement Till are dominant in the inclusions of marine sediment, whereas local lithologies dominate the more massive diamicton within the deposit. Numerous fold and shear structures occur within the Basement Till, often manifest as smudges of chalk or preferentially weathered stringers of sand in an otherwise massive diamicton (Eyles *et al.,* 1994). Pebble fabrics indicate a glacier flow direction from the north-east (Penny and Catt, 1967), but the upper layers are often disturbed by large folds and shear structures that cross-cut the fabric orientation (Catt and Penny, 1966; Penny and Catt, 1967; Eyles *et al.,* 1994). Large rafts of older sediments are often particularly well exposed in the Basement Till at Dimlington. For example, dark blue marine clays with abundant shells, similar to deposits referred to as the 'Bridlington Crag' by Reid (1885), occur as rafts and smaller inclusions (Catt and Penny, 1966; Eyles *et al.,* 1994). The faunal lists compiled for the blue clays by Reid (1885), Lamplugh (1884b, 1890) and Bell (1917, 1919) indicate a mixed assemblage of arctic littoral and deep-water species, although similar rafts at Bridlington contain species of a mixture of ages, including some as old as the Pastonian (Reid and Downie, 1973). Many shell fragments also can be found in the clay matrix of the Basement Till where it appears as a massive diamicton. The upper surface of the Basement Till at Dimlington is described as 'discoloured, decalcified and fragmented' by Catt and Penny (1966).

A number of depressions on the upper surface of the Basement Till contain laminated silts grading upwards into sands, a sediment body termed the 'Dimlington Silts' (Bisat and Dell, 1941; Catt and Penny, 1966; (Figure 5.28)). The Dimlington Silts occur as discontinuous lenses truncated by the overlying Skipsea Till and contain layers of moss (Bisat and Dell, 1941; Bisat, 1948), dominated by *Pohlia wahlenbergii* var. *glacialis,* in addition to insects and freshwater ostracods indicative of cold climatic conditions (Table 5.5). The bedding of the Dimlington Silts typically parallels the basin floor, but upper beds often display post-depositional disturbance in the form of folds, which appear to record stress directions from the north and north-east (Catt and Penny, 1966). The alternation of sand- and silt-dominated laminae indicate changes in the sediment supply to the deep water environment in which the Dimlington Silts were deposited. Eyles *et al.* (1994) report a range of sedimentary structures from massive and laminated silty clays to interbedded silty clays and sands, including mud drapes over sand ripples (flaser bedding) and starved ripples. Radiocarbon dates of 18 500 years BP and 18 240 years BP were obtained on the moss layers by Penny *et al.* (1969), providing a maximum age for the deposition of the overlying Skipsea Till.

Truncating the Dimlington Silts and the Basement Till at Dimlington are the Skipsea and Withernsea tills. In previous classification schemes for the Holderness glacial sequence (Table 5.4) these deposits have been referred to as the 'Drab Till' and 'Purple Till' (Bisat, 1939, 1940; Catt and Penny, 1966; Catt and Madgett, 1981). The two tills are clearly differentiated by colour, erratic content, grain size and mineralogy (Madgett and Catt, 1978). Specifically, the Skipsea Till is very dark greyish brown, sandy in matrix texture, rich in garnet, hornblende, staurolite and kyanite, and is dominated by chalk and flint lithologies in addition to farther travelled igneous and metamorphic pebbles, including Scandinavian erratics. In contrast, the Withernsea Till is dark brown, possesses a clay-rich matrix, and is dominated by shale, siltstone and limestone lithologies. The textural and structural complexity of the Skipsea and Withernsea tills led Bisat (1939, 1940) to propose detailed stratigraphical subdivision of the deposits, but more recent research prefers a simple two-tier stratigraphy (Catt and Penny, 1966; Madgett and Catt, 1978; Catt, 1987b; Eyles *et al.,* 1994; Evans *et al.,* 1995). Early work on the Holderness glacial sequence identified a further more recent deposit, the Hessle Till, which Madgett and Catt (1978) later revealed to be a Holocene weathering profile in the Skipsea or Withernsea Till, depending on which deposit was at the surface.

The geographical distribution of the Withernsea Till (Figure 5.29) is far more restricted than the Skipsea Till although it is thought to extend some distance offshore (Cameron *et al.,* 1987). It extends a maximum distance of 10 km inland from the present coast but its landward margin trends offshore at Easington in the south and at Mappleton in the north (Catt and Penny, 1966; Madgett, 1975). The Withernsea and Skipsea tills are separated by a sharp erosional contact along which numerous discontinuous lenses of sands and silts and occasionally gravels lie in shallow scours on the surface of the Skipsea Till. Pebble fabrics taken from the Skipsea and Withernsea tills by Penny and Catt (1967), reveal a consistent north-east to south-west ice flow direction.

Interpretation

The abundance of marine fauna in the Basement Till led Penny (1959) to propose a marine origin for the deposit. However, the erratics, pebble fabrics and structures clearly indicate that the deposit was produced by subglacial transport (Catt and Penny, 1966; Penny and Catt, 1967) most probably as a deforming layer (Eyles *et al.,* 1994). The rafts of blue marine clay were eroded from pre-existing marine deposits by the North Sea glacier lobe as it moved towards the Yorkshire coast. The occurrence of shells within the matrix of the Basement Till indicates that the massive diamicton has been produced by the deformation and kneading of pre-existing marine deposits. Because they occur in association with marine muds and arctic fauna, the Scottish and Scandinavian erratics in the blue marine clay rafts were most probably originally deposited on the North Sea floor by icebergs prior to the Dimlington Stadial glacier advance (Catt and Penny, 1966). Although Catt and Penny (1966) and Catt (1987b) have suggested that the Basement Till dates to a pre-Ipswichian glaciation, amino acid ratios on the incorporated shells indicate a Late Devensian age for the glacier advance (Eyles *et al.,* 1994). Local erratics were incorporated into the Basement Till as it was transported on to the Yorkshire coastal lowlands from the North Sea as a subglacial deforming layer (Catt and Penny, 1966; Eyles *et al.,* 1994).

(Table 5.5) The flora and fauna of the Dimlington Silts.

Coleoptera
Agabus bipustulatus L.
Aleocharinae indet.
Amara alpina Paykull
Amara quenseli Sch.
Aphodius sp.
Arpedium brachypterum Gr.
Bembidion sp. (*lunatum* group)
Bledius fuscipes Rye
Byrrhus sp.
Cercyon sp.
Feronia blandulus Mill.
Hydrobius sp.
Notaris aethiops F.
Ostracoda
Candona neglecta Sars
Cypridopsis vidua (Mull.)
Cyprinotus salinus (Brady)
Eucypris gemella Bodina
Ilocypyris gibba (Ramdohr)
Plants
Daphnia ephippia
Eleocharis palustris (L.)
Menyanthes trifoliata (L.)
Pohlia wahlenbergii (Web. & Mohr) *glacialis* (Schleich.)
Potamogeton alpinus Potamogeton filiformis
Trees
Pinus (sparse pollen)
Betula (sparse pollen)

The Dimlington silts are interpreted as lake deposits, which accumulated prior to the Skipsea Till glacier advance approximately 18 000 years BP The folding in the silts and the Basement Till is interpreted as glaciotectonic in origin (Catt and Penny, 1966; Eyles *et al.,* 1994), produced within a push moraine that eventually was overridden and capped by Skipsea Till. The flora and fauna of the organics enclosed within the Dimlington Silts (Table 5.5) indicate a shallow, freshwater lake surrounded by sparse vegetation and containing a restricted aquatic flora. This is typical of the environmental conditions in Britain leading up to the Last Glacial Maximum. The radiocarbon dates of 18 500 and 18 240 years BP are comparable with others used to constrain the start of the Dimlington Stadial in the region (Rose, 1985; (Figure 5.30)).

The clear differences in the Skipsea and Withernsea tills and the erosional contact that separates them have been used by Carruthers (1953), Catt and Penny (1966), Madgett and Catt (1978) and Edwards (1981) to suggest that a 'two-tiered' glacier was responsible for till deposition. Specifically, they suggest that superimposed tributary glaciers invaded the East Yorkshire coast during the Dimlington Stadial, each tributary carrying its own characteristic suite of erratics. The Skipsea Till was deposited by ice originating in Northumberland and southern Scotland and flowing southwards along the Yorkshire coast, whereas the Withernsea Till was deposited by a Tees valley ice stream that overrode the Skipsea Till ice and was then carried 'piggyback' style southwards to the Holderness area. Thus, the superimposition of Withernsea Till over Skipsea Till is explained by simultaneous deposition. Sedimentologically, more has been made of the stratified sediment bodies that occur between and within the Skipsea and Withernsea tills by Eyles *et al.* (1994). They suggest that the stratified sediments document periods of submergence by marine waters between onshore surges by the North Sea glacier lobe. A comparison is drawn between the glacial deposits of Dimlington and the pro-glacial sediments of the Sefstrom surging glacier in Svalbard, orginally described by Lamplugh (1911). In this depositional scenario the Basement, Skipsea and Withernsea tills are all regarded as the products of subglacial deformation of pre-existing marine

or glaciomarine sediments during the Devensian glaciation. Although the occurrence of flaser bedding in the Dimlington Silts is diagnostic of tidal influences, the suggestion of a marine, rather than a lacustrine, origin for the stratified sediments in the Dimlington glacial sequence remains contentious. Nonetheless, the repeated onshore surging or regular (steady state) subglacial deformation theory (Eyles *et al.,* 1994; Evans *et al.,* 1995) appears to provide a more complete explanation of the similarities of the Skipsea and Withernsea tills than that provided by the 'piggyback' or simultaneous deposition model.

The most recently revised correlation of Quaternary deposits in the British Isles (Bowen, 1999) has renamed 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 Skipsea and Withernsea tills are called the 'Skipsea Member' and Withernsea Member' and the intervening sands and gravels are the 'Mill Hill Member'. The Dimlington Silts and their incorporated organic material are now labelled the 'Dimlington Bed'. A further unit, the 'Hornsea Member', has been provided for the hummocky terrain in the region, although it is not clear why this terrain is regarded as separate from and younger than the Withernsea Member. These members and the Dimlington Bed are all part of the Holderness Formation.

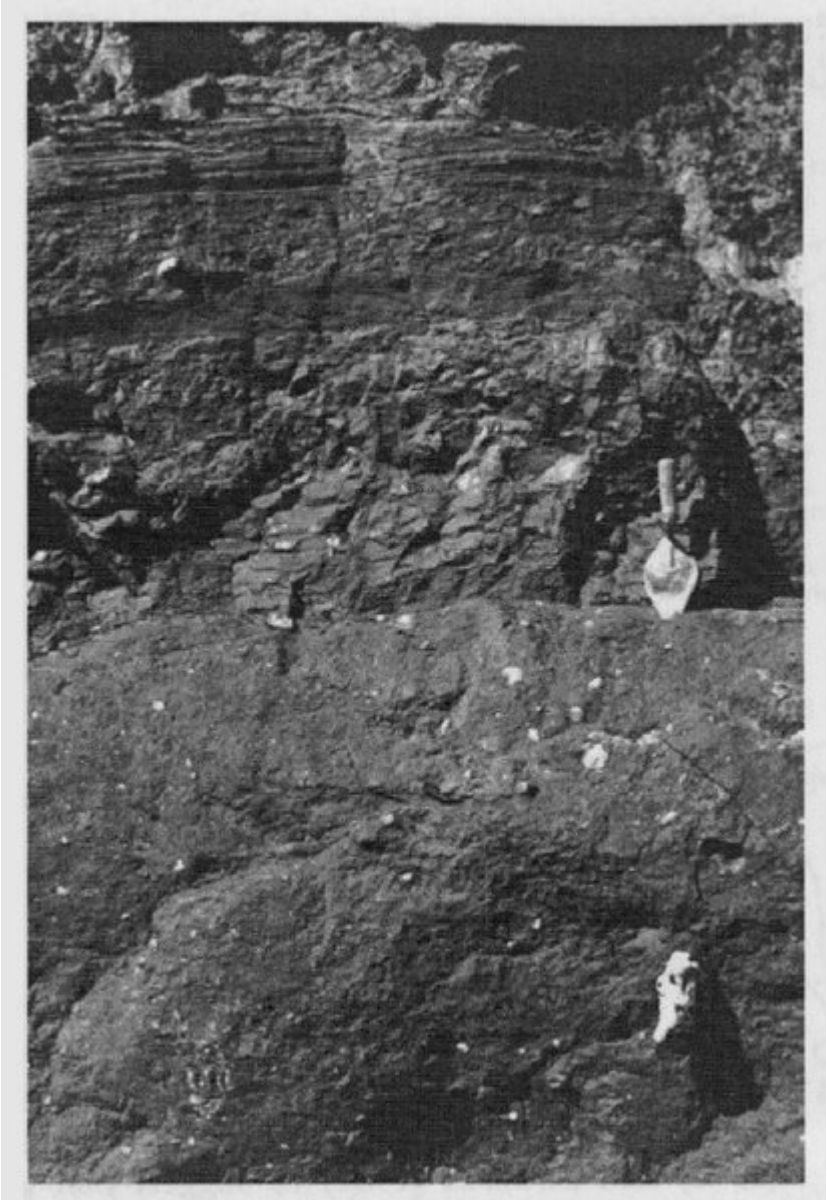
Conclusions

Dimlington is of considerable importance to British Quaternary stratigraphy because of its pre-Late Devensian and Late Devensian tills separated by radiocarbon dated organics. Owing to the clarity of the chronostratigraphical evidence at Dimlington it is used as the type site for the phase of maximum expansion of the British ice sheet during the Late Devensian, a period known as the 'Dimlington Stadial'. The climatostratigraphical episode represented by the site is named the 'Dimlington Chronozone' and covers the period 26 000–13 000 years BP (Rose, 1985). Dimlington and the nearby sites of Roos and Tunstall, the latter two containing radiocarbon dated organic materials witnessing the close of the Dimlington Stadial (Figure 5.30), provide excellent chronostratigraphical bracketing of Late Devensian glaciation. Owing to the ongoing erosion and fresh exposure of multiple tills by storm waves, this stretch of the east Yorkshire coast will continue to provide further new evidence for the reconstruction of the depositional settings and dynamics of the former southern margin of the British ice sheet in the North Sea.

References

Dimlington Silts/ Basement Till	Skipsea Till	Withernsea Till	Source
Basement Till Chalk rubble	Greenish-purple Till Gravel	Hessle Till Brown Till	Lamplugh (1879)
	Interstratified series	Upper Till	Lamplugh (1891a,b)
Basement Clay Sub Basement Clay	Upper Drab Clay Middle Drab Clay Chalk rafts Lower Drab Clay Sub Drab Clay Basement Drab Clay Sand, silt and gravel	Upper Purple Clays (2 beds) Gravels Lower Purple Clays (3 beds)	Bisat (1939, 1940)
Dimlington Silts Basement Till (Series)	Drab Till	Hessle Till Purple Till	Catt (1963) Catt and Penny (1966)
Chalk rubble Basement Till Speeton Shell Bed	Lower Till Gravel	Upper Till Unnamed Till	Mitchell *et al.* (1973)
Chalk rubble Basement Till Chalk rubble Speeton Shell Bed	Lower Till Series Gravel	Upper Till Series	Edwards (1981)

(Table 5.4) Nomenclature of the Quaternary deposits of Holderness compared to the tripartite scheme of Madgett and Catt (1978) (from Evans et al., 1995).



(Figure 5.28) Dimlington Silts overlying Basement Till at Dimlington. (Photo: J. Rose.)

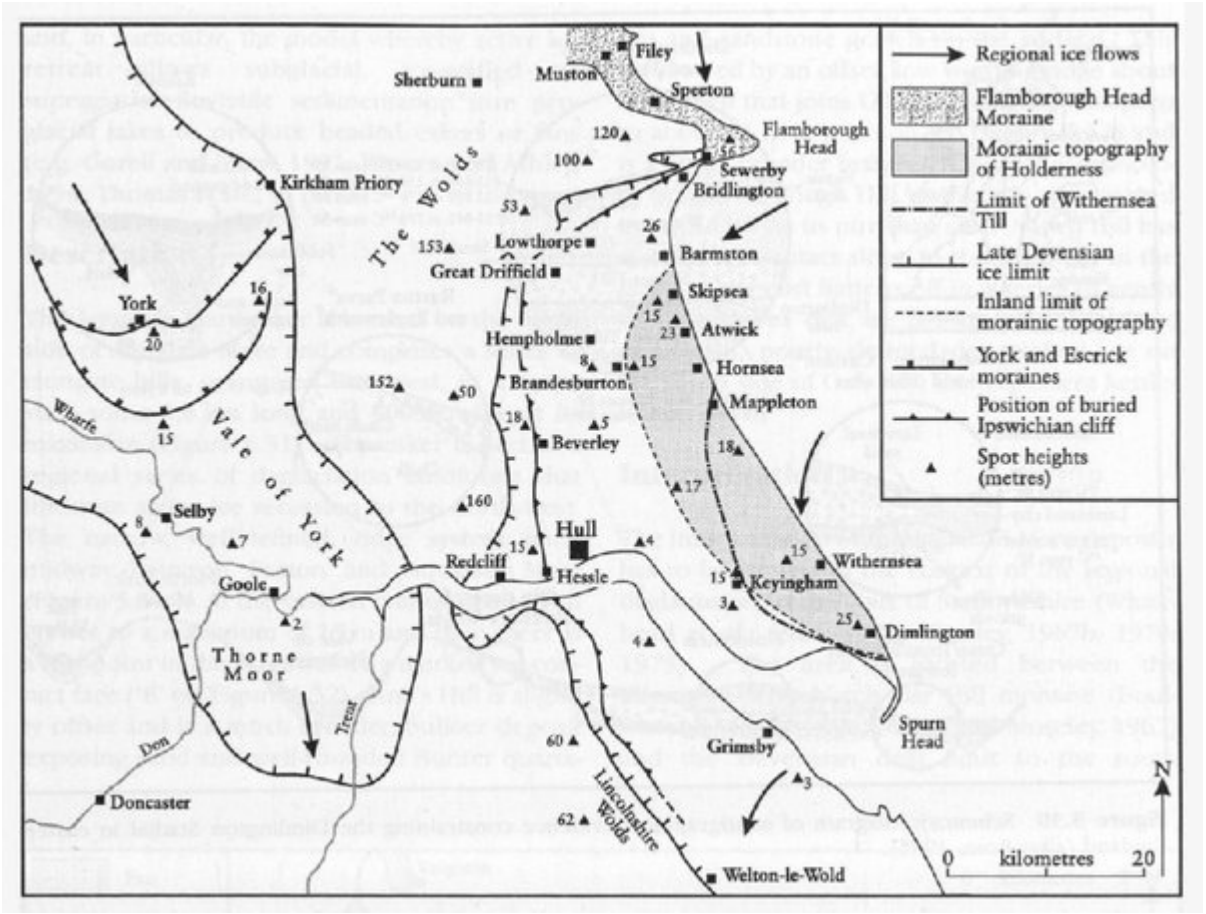
Coleoptera
Agabus bipustulatus L.
Aleocharinae indet.
Amara alpina Paykull
Amara quenseli Sch.
Aphodius sp.
Arpedium brachypterum Gr.
Bembidion sp. (*lunatum* group)
Bledius fuscipes Rye
Byrrhus sp.
Cercyon sp.
Feronia blandulus Mill.
Hydrobius sp.
Notaris aethiops F.

Ostracoda
Candona neglecta Sars
Cypridopsis vidua (Mull.)
Cyprinotus salinus (Brady)
Eucypris gemella Bodina
Ilocypyris gibba (Ramdohr)

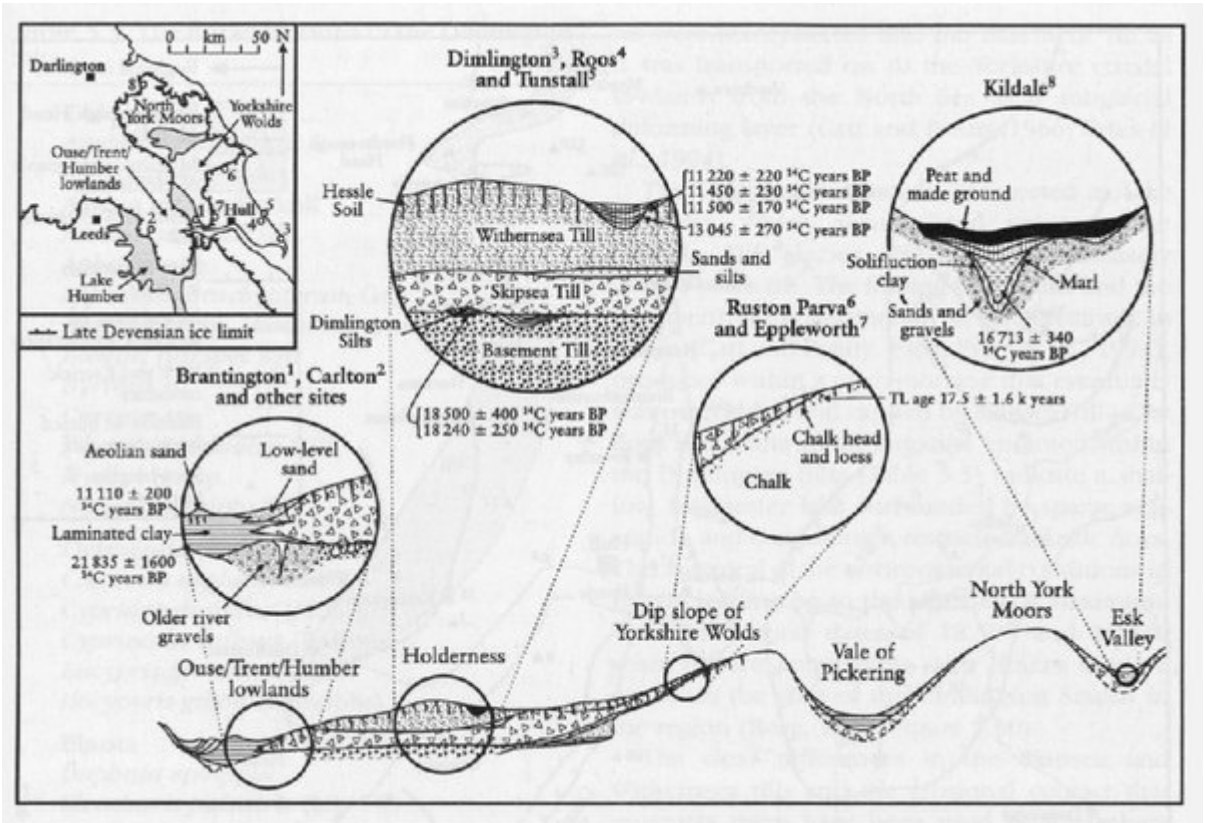
Plants
Daphnia ephippia
Eleocharis palustris (L.)
Menyanthes trifoliata (L.)
Pohlia wahlenbergii (Web. & Mohr)
glacialis (Schleich.)
Potamogeton alpinus
Potamogeton filiformis

Trees
Pinus (sparse pollen)
Betula (sparse pollen)

(Table 5.5) The flora and fauna of the Dimlington Silts.



(Figure 5.29) Map of Holderness showing the distribution of the Skipsea and Withernsea tills and important stratigraphical sites, based upon Eyles et al. (1994) and other various sources.



(Figure 5.30) Schematic diagram of stratigraphical evidence constraining the Dimlington Stadial in eastern England (after Rose, 1985).