The Dimlington Stadial/Dimlington Chronozone: a proposal for naming the main glacial episode of the Late Devensian in Britain

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The term Dimlington Stadial is proposed as a climatostratigraphic name for the main glacial episode of the Late Devensian in Britain, in preference to stratigraphically unsatisfactory terms, such as Late Devensian Glaciation (which includes the Windermere Interstadial and the Loch Lomond Stadial), ice-sheet glaciation or maximum of ice expansion, that are currently in use. The name is selected from a site on the East Yorkshire coast and refers to the interval between 26,000 and 13,000 radiocarbon years B.P. Dimlington Chronozone is the formal chronostratigraphic term for the equivalent period of time, and comprises the main part of the Late Devensian Sub-stage.

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There is, at present, no satisfactory term to describe the period of maximum glacier expansion in the Late Devensian Substage between 26,000 and 13,000 radiocarbon years B.P. No name exists employing the appropriate stratigraphic term 'stadial' (Hedberg 1976) and the expressions currently or recently used are both stratigraphically unsound or inconveniently lengthy. For instance the most usual expression is 'Late Devensian Glaciation' (Shotton 1977) which includes two major episodes of climatic deterioration separated by a clearly definable climatic amelioration known as the Windermere Interstadial (Coope 1977; Pennington 1977). The phrases 'main Late Devensian glaciation' (Shotton 1977:117), 'phase of maximum expansion of ice sheets' (Coope 1975:162), 'period of maximum ice expansion' (Coope 1977:313) and 'Late Devensian ice-sheet' (Sissons 1981:3; West 1977:307) have been used to differentiate the main period of glaciation between 26,000 and 13,000 B.P. from that of the Loch Lomond Stadial between about 11,000 and 10,000 B.P. The unsatisfactory nature of this situation is illustrated most clearly in Coope (1977:313) where the subdivisions of the Devensian are summarized briefly and identified, in all cases except one, simply by their stratigraphic names: Chelford Interstadial, Upton Warren Interstadial complex, Windermere Interstadial and Loch Lomond Stadial. The one exception is the period between about 26,000 and 13,000 years B.P., which does not have a name, and it is inconveniently known as the 'period of maximum ice expansion'.

Coope's list also makes it clear that there are other episodes in the Devensian that are not defined as stadials or interstadials, such as the interval of relative cold between the Chelford and Upton Warren Interstadials, although this simple example is now complicated by the recognition of the Brimpton Interstadial (Bryant *et al.* 1983) within this period. These are not, however, the subject of this note, largely because satisfactory evidence and type sites do not yet exist. This is not the case for the period between 26,000 and 13,000 radiocarbon years B.P. Satisfactory evidence does exist and it is for that reason that a climatostratigraphic name is being proposed, along with a formally defined chronozone.

Stratigraphic basis

In climatostratigraphic terms this episode is a stadial of the Devensian Glaciation. In chronostratigraphic terms it is a chronozone of the Devensian Stage. It is represented by a stratotype at Four Ashes near Wolverhampton (Morgan 1973; Mitchell *et al.* 1973; Shotton 1977) (Fig. 1). It is preceded by the Upton Warren Interstadial, defined from a type-site of that name (Coope *et al.* 1961; Coope & Sands 1966:393) (Fig. 1) and succeeded by the Windermere Interstadial represented by sediments from Lake Windermere in

the English Lake District (Pennington 1977; Coope 1977) (Fig. 1). Climatically, it is considered, at present, to represent a single cycle of deterioration and amelioration (Coope 1975) with possible minor interruptions reflected in oscillations of the ice-margin during the ameliorating phase (the possible Perth Readvance of Sissons (1963) and the Wester Ross Readvance of Robinson and Ballantyne (1979)), named according to their representative localities. Clearly, a representative site, which can also give its name, is required for this episode. Four Ashes was selected as the type site for the Devensian because it has 'deposits of Late, Middle, and Early Devensian above an Ipswichian horizon' (Shotton 1977:111), but the glacial event is only poorly represented by a cryostatically disturbed and locally discontinuous till, and the minimum age for glaciation given by the biostratigraphy and the radiocarbon dates are not closely related to the event of glaciation.

It is proposed that the evidence from Dimlington on the East Yorkshire coast fulfils the requirements of a type site for this episode. The locality has been described in detail and placed in a regional context by Catt & Penny (1966), Madgett (1975) and Madgett & Catt (1978) (Fig. 2). The evidence for glaciation consists of two till units, the Skipsea and Withernsea Tills deposited by a range of glacigenic processes, with interdigitating and overlying glacifluvial sands and gravels. The *in situ* position of these sediments has been demonstrated by fabric work (Penny & Catt 1967) and the extent of post-formational modification has been analysed and identified as a weathering profile, formerly known as the 'Hessle Till' (Madgett 1975; Madgett & Catt 1978). The tills can be placed in stratigraphical position because they directly overlie the Dimlington Silts which contain moss, and Coleoptera with glacial affinities, and have yielded two independently determined radiocarbon dates of 18,500 ± 400 B.P. and 18,240 ± 250 B.P. (Penny *et al.* 1969), and are overlain by lake deposits that yield pollen and maximum radiocarbon ages of 16,713 ± 340 B.P. (Jones 1977; Keen *et al.* 1984, Kildale in the North York Moors) and 13,045 ± 270 B.P. (Beckett 1977, Roos Bog near Dimlington). These last dates may be affected by hard water errors, but they are not inconsistent with other radiocarbon determinations from a similar stratigraphic position elsewhere in Britain.

The regional context of the Skipsea and Withernsea Tills means that the glacial episode can be related to loess stratigraphy (Catt *et al.* 1974) and this material can be dated according to its stratigraphic position by radiocarbon, and directly by thermoluminescence, to between about 19,500 and 14,500 B.P. (Catt 1978; Wintle 1981; Wintle & Catt 1985). Similarly the glacial episode can be related to proglacial lake deposits in the Ouse/Trent/Humber lowlands that can be shown by radiocarbon determination to have a maximum age of 21,835 ± 1,600 (Gaunt 1976, 1981).

The evidence from Dimlington and the adjacent region therefore fixes the maximum of the Late Devensian glaciation in eastern England to between about 18,000 and 16,000 B.P. The time at which glaciers began to expand and finally melted away cannot be resolved with any precision because of the lack of dating evidence in the source region. However, radiocarbon dates from the Glasgow area, relatively close to this source region, indicate ice-free conditions in that region until 27,550 ± 1,370 – 1,680 B.P. (Rolfe 1966) and after 13,780 ± 124 B.P. (Browne *et al.* 1983). Finally there is no reason why the maximum of glaciation should be precisely synchronous in different parts of Britain. As emphasized by Shotton (1977), four radiocarbon dates between 18,900 and 18,400 B.P. from the Isle of Man suggest the ice wastage had begun by this time, whereas a radiocarbon date of 18,000 ± 1,200 from Tremeirchion in the Vale of Clwyd (Rowlands 1971) suggests a slightly later advance at the eastern margin of the Irish Sea basin. These differences most probably reflect the imprecise and potentially ambiguous nature of radiocarbon dating as well as a range of glacier response rates caused by differences in mass balance, bed material and topography. They do not conflict with the evidence from Dimlington and eastern England, and can be readily accommodated in the scheme of a Dimlington Stadial and Chronozone.

Also of importance is the fact that the site at Dimlington is usually accessible, and coastal erosion is likely to maintain exposures for future workers. It has been visited widely by the participants at national and international meetings, such as the Quaternary Research Association in 1972 (Penny *et al.* 1972), the Yorkshire Geological Society in 1976 (Catt & Madgett 1977), and the X INQUA Congress in 1977 (Catt 1977), each of which produced detailed site descriptions, and by many students from British and overseas universities and polytechnics.

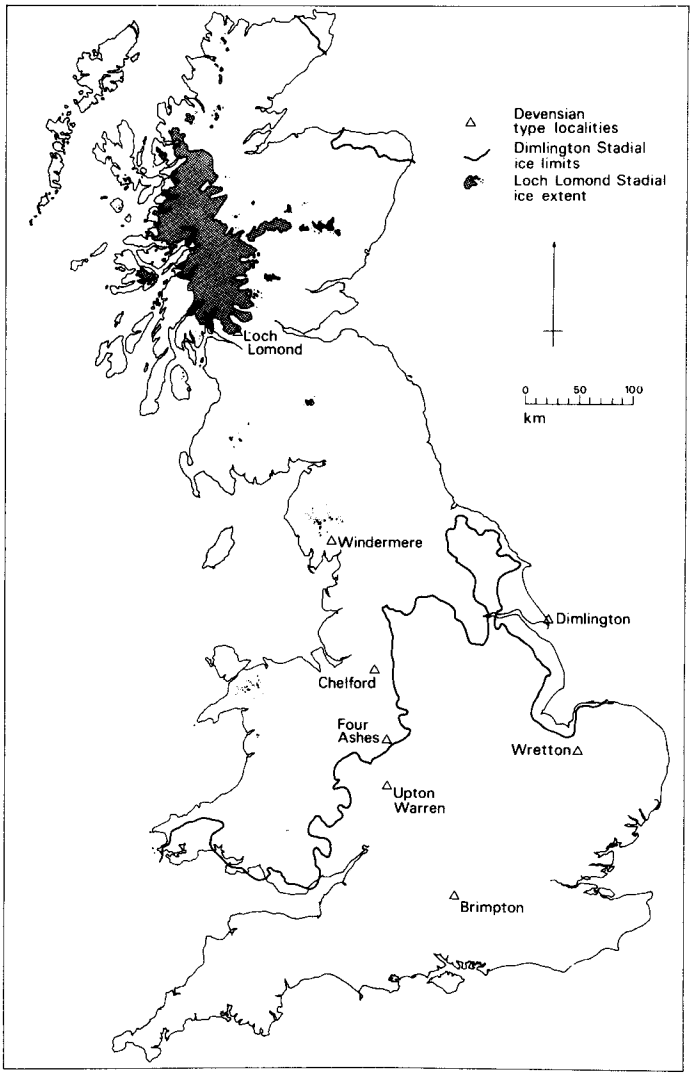
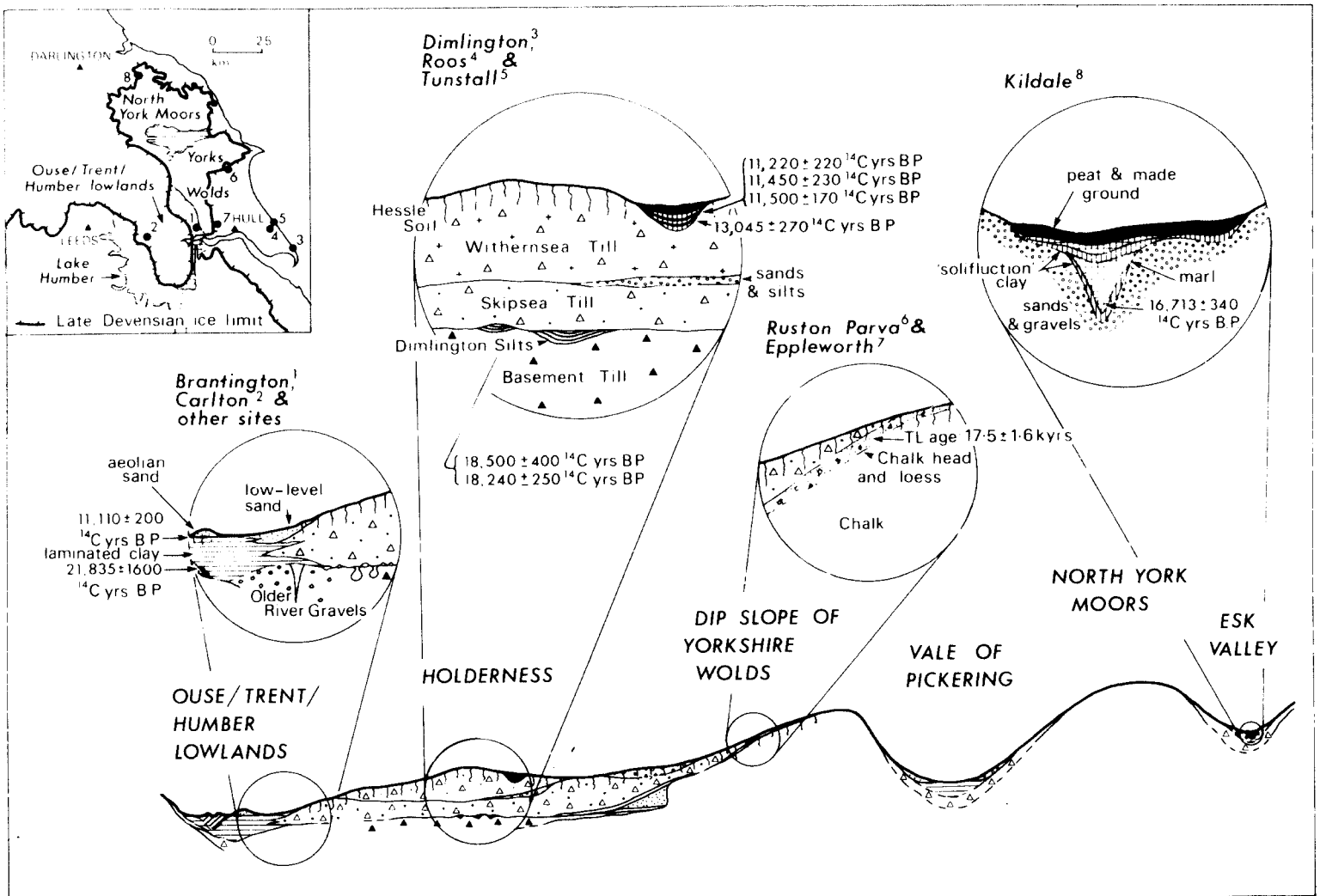


Fig. 1. Location of Dimlington and other Devensian type sites. Dimlington Stadial and Loch Lomond Stadial ice limits are shown. The position of the Dimlington Stadial ice limits in Scotland are based on Sutherland (1984).

Discussion

Inevitably, a proposal for a new stratigraphic name introduces problems caused by procedure and site suitability (Mangerud *et al.* 1974, 1982; Mangerud & Berglund 1978; Hedberg 1976), and questions the status of existing terms. In Britain a chronostratigraphy has been proposed for the period since 50,000 years B.P. with a subdivision between the Middle and Late Devensian Substages at 26,000 years B.P. and subdivision between the Late Devensian Substage and Flandrian Stage at 10,000 years B.P. (Mitchell *et al.* 1973). However, these boundaries are based on climatic events and are therefore inherited from climatostratigraphy. The same applies to the Windermere Chronozone between 13,000 and 11,000 years B.P. and the Loch Lomond Chronozone between 11,000 and 10,000 years B.P., which are based on the Windermere Interstadial and Loch Lomond Stadial respectively. This problem is not unique to Britain, and has been discussed in relation to Norden by Mangerud *et al.* (1974), Mangerud & Berglund (1978) and Mangerud (1982), but it does involve an inherent contradiction in that climatostratigraphic units may have time transgressive boundaries, whereas chronostratigraphic boundaries do not, as they are defined by dates. On the other hand it has the advantage that different names are not pro-


DARLINGTON
0 25
km
North York Moors
Yorks
Ouse/Trent/ Humber lowlands
Wolds
HULL
LEEDS
Lake Humber
Late Devensian ice limit
Dimlington,[3] Roos[4] & Tunstall[5]
11,220 ± 220 14C yrs BP
11,450 ± 230 14C yrs BP
11,500 ± 170 14C yrs BP
13,045 ± 270 14C yrs BP
Hessle Soil
Withernsea Till
sands & silts
Skipsea Till
Dimlington Silts
Basement Till
18,500 ± 400 14C yrs BP
18,240 ± 250 14C yrs BP
Kildale[8]
peat & made ground
'solifluction' clay
marl
sands & gravels
16,713 ± 340 14C yrs BP
Ruston Parva[6] & Eppleworth[7]
TL age 17·5 ± 1·6kyrs
Chalk head and loess
Chalk
Brantingston,[1] Carlton[2] & other sites
aeolian sand
low-level sand
11,110 ± 200 14C yrs BP
laminated clay
21,835 ± 1600 14C yrs BP
Older River Gravels
OUSE/TRENT/ HUMBER LOWLANDS
HOLDERNESS
DIP SLOPE OF YORKSHIRE WOLDS
VALE OF PICKERING
NORTH YORK MOORS
ESK VALLEY

liferated and that particular time-stratigraphic events may have a climatological and environmental connotation which can aid communication.

The extent to which the allocation of climato-stratigraphic and chronostratigraphic boundaries can be a problem is illustrated in parts of the North American Mid-West where the boundary between the Wisconsinan and Holocene Stages, based on geological indications of climatic change, has been given different ages in different areas (Evenson *et al.* 1977). The success of any scheme will depend mainly upon its appropriateness and practicality, and the hierarchical scheme used in Britain and Norden appears, at least at present, to be reasonably successful. The Devensian/Weichselian Stage roughly accords with oxygen isotope stages 4–2. Devensian substage divisions roughly approximate with oxygen isotope stages 4, 3 and 2 and thus equate with climatic changes that are on a scale that is sufficiently large and widespread to be recognized on the oxygen isotope curves. Finally, chronozone subdivisions are primarily regionally based and therefore sufficiently flexible to accommodate local variations (Mangerud *et al.* 1982) and overcome many of the problems outlined by Watson & Wright (1980). To a degree the problems in the United States Mid-West arise from the allocation of too high a stratigraphic status (substage) to events of too small a stratigraphic significance.

Two other problems relate specifically to the definition of the Dimlington Stadial. Firstly, there is the problem of the age of the lower boundary. In many respects the age 39,000 years B.P., representing the end of a moderately oceanic climate and the beginning of a cold continental climate in lowland central England, marks a more significant climatic boundary than 26,000 years B.P., which represents a change from cold continental climate to polar climate (Coope 1977). However, the definition of the upper boundary of the Upton Warren Interstadial Complex as 26,000 years B.P. (Coope & Sands 1966:393) takes precedence and is therefore preserved. Also the date of 26,000 years B.P. coincides with the formally proposed boundary between the Middle and Late Devensian Substages (Mitchell *et al.* 1973), and there is no overwhelming reason to over-ride this. Secondly, there is the problem that the silts at Dimlington have been taken as evidence for interstadial conditions (Catt & Penny 1966) and this episode was tentatively called the 'Dimlington Interstadial' (Catt & Penny 1966:390). Subsequent examination of the Coleoptera from the Dimlington Silts suggested, however, that they were deposited 'not in an interstadial, but during the Upper Pleniglacial (approx. 29,000–13,000 years B.P.), which was the period of maximum Weichselian glaciation of the continent of Europe' (Penny *et al.* 1969:66).

Conclusion

It is proposed that the phase of maximum expansion of ice sheets during the Late Devensian in Britain should be known as the Dimlington Stadial, and that this climatostratigraphic episode is the equivalent of the Dimlington Chronozone, which represents a period of time from 26,000 to 13,000 radiocarbon years B.P. The Dimlington Chronozone is almost exactly equivalent to the Upper Pleniglacial Chronozone of The Netherlands, which is considered to have begun about 27,000 years B.P. and ended at 13,000 years B.P. (Van der Hammen 1971; Kolstrup 1980).

This paper is written in conjunction with one by Wintle & Catt (1985) describing thermoluminescence dating of some of the Dimlington Stadial deposits.

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Fig. 2. Diagrammatic representation of stratigraphic evidence for the Dimlington Stadial in eastern England. An inset map shows the site locations in the region from the Ouse/Humber/Trent lowlands in the south, to the North York Moors in the north, and the relation of the sites to the late Devensian ice limit (Madgett & Catt 1978). Formational names and lithological descriptions are given for the Dimlington, Roos & Tunstall evidence, and are represented by equivalent symbols at the other sites, except for the Devensian Till north of the Yorkshire Wolds which is not differentiated into Skipsea and Withernsea types.

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