Harwood Dale Moor

[SE 961 991]

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Introduction

Harwood Dale Moor, North Yorkshire, is an important locality for British Quaternary stratigraphy as soil pits at the site have provided evidence for a 'fossil soil' (palaeosol) developed in weathered clays of the Middle Jurassic Estuarine Beds. The palaeosol displays prominent red mottling and is interpreted as having developed under either tropical or subtropical conditions. Although the precise age of the palaeosol remains uncertain the site provides important information on environmental changes and the extent of glaciation in the North York Moors (Figure 4.32).

Ruhe (1956) originally defined the term 'palaeosol' as any soil that has developed on a former land surface, with the intention that the term be applied essentially to 'fossil' (preserved) soils. This definition was amplified by Bronger and Catt (1989) to include non-buried soils that have persisted on a land surface through one or more environmental changes and bear their imprint in the form of relict pedological features that are not in harmony with the present environment. The term 'palaeosol' has, however, been widely used by Quaternary scientists to describe soils that are buried beneath younger sediments, those that are no longer affected by soil-forming processes, or those that are essentially relict features (Lowe and Walker, 1997a; Johnson, 1998). Palaeosols often form under markedly different environmental conditions to those of the present day; by relating the palaeosol horizons to those of modern soils from a range of climatic environments it is possible to make deductions about the environment at the time of soil formation (Dahms, 1998). In particular, palaeosols provide valuable information concerning former climate and vegetation.

Palaeosols are normally identified and described in terms of colour differences, particle-size distribution, clay-mineral composition, organic content and soil macrostructures (Catt, 1986). Recent advances now include the use of soil micromorphology (Kemp, 1985a, 1998; Catt, 1990a; Fitzpatrick, 1993) and mineral magnetic analysis (Thompson and Oldfield, 1986). The use of palaeosols in the reconstruction of Quaternary environments and their significance for Quaternary stratigraphy is discussed by Rose *et al.* (1985a), Catt (1986) and Lowe and Walker (1997a). The classification of palaeosols is outlined by James *et al.* (1998) and by Nettleton *et al.* (1998).

The palaeosol for which Harwood Dale Moor is noted was discovered during soil mapping by the Forestry Commission and the Soil Survey of England and Wales. Carroll and Bendelow (1981) have described the soils of the North York Moors, including the palaeosol features at this site. A regional description and overview of palaeosol features in northern England is provided by Bullock *et al.* (1973).

Description

Harwood Dale Moor lies on the eastern edge of the North York Moors, approximately 13 km to the north-west of Scarborough. The site lies within forestry at an altitude of 210 m OD. The North York Moors is situated on a large expanse of Jurassic rocks rising to over 450 m in altitude, formed mainly of Middle Jurassic (Callovian) marine limestones, sandstones and shales (Wright, 1860; Fox-Strangways, 1892; Wright, 1968, 1977, 1978; Page, 1989). Harwood Dale Moor, on the eastern edge of the moor, is underlain by clays of the Middle Jurassic Estuarine Beds. The Harwood Dale Moor palaeosol itself is a peaty gley overlying weathered clays of the Estuarine Beds. Carroll and Bendelow (1981) classify the soil as a stagnohumic gley with prominent mottling in the Bg horizon. The mottles are reddish-brown in colour (Munsell Colour 2.5 YR and 10 R) and up to 15 cm in diameter. The mottles are so intense that they form the dominant colour. Chemically, the mottles contain crystalline goethite and haematite. The morphology and mineralogy of the iron compounds in the red mottled clays resembles plinthite, a red mottled clay common in tropical regions where there is a marked wet and dry season (Bullock *et W.,* 1973). The precise extent of the mottling is uncertain, although this type of soil appears to cover large areas of the North York Moors plateau (Carroll and Bendelow,

1981).

Interpretation

Palaeosols are relatively abundant throughout Britain and the significance of the Harwood Dale Moor palaeosol lies in its composition, stratigraphical context, and in the debate about the location of the Late Devensian ice margin in this area. In particular the preservation of an interglacial soil has implications for the extent to which the North York Moors escaped glaciation during the Late Devensian. It is a widely held belief that this area escaped glacierization in the Dimlington Stadial owing to its relatively high altitude (Jones and Keen, 1993). Thus, although similar palaeosol features may have existed throughout this area of northern England, many have been removed by glacial erosion. The remnants of this episode of pedogenesis are commonly assumed to survive only in areas that escaped glacierization, but also it is possible that they survive in areas simply where glacial erosion was ineffective. Similar preglacial landscape remnants exist in north-east Scotland, where Pliocene and early Pleistocene weathering mantles also are known to have escaped the effects of glaciation (Fitzpatrick, 1963; Sugden, 1968, 1989; Hall, 1985, 1991; Hall and Sugden, 1987; Hall and Mellor, 1988; Hall *et al.,* 1989; Ballantyne, 1994). The survival of these Scottish weathering covers owes much to the selectivity of glacial erosion and to the basal thermal regime of the ice sheet in this area (Sugden, 1968; Clapperton and Sugden, 1977; Hall and Sugden, 1987; Sugden *et al.* 1992). Patches of former weathering mantles have been related to cold-based zones beneath the former ice sheets in topographically suitable locations (Hall and Sugden, 1987; Glasser and Hall, 1997). Modelling studies have shown that the favoured location for the survival of a former weathering mantle is on upland and plateau areas where rates of ice flow are generally low and the ice is cold-based (Glasser, 1995). This raises the intriguing possibility that the palaeosol at Harwood Dale Moor is in fact an isolated remnant of a previously more widespread soil cover across the North York Moors that was preserved beneath cold-based ice.

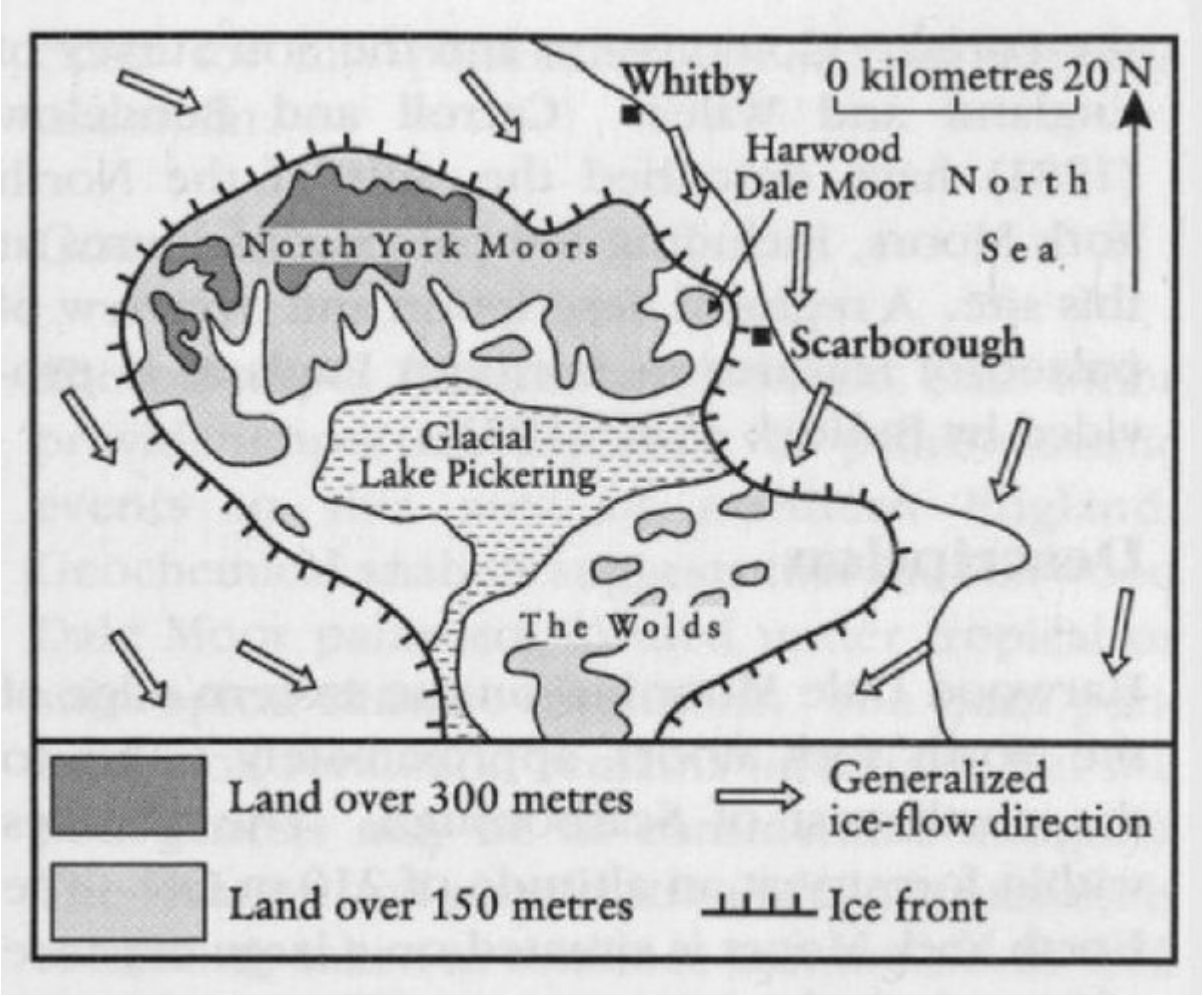
The palaeosol features at Harwood Dale Moor also make an interesting comparison with other palaeosols in Britain. These include palaeosols formed under temperate climatic conditions such as the Valley Farm Soil (Rose *et al.,* 1978; Kemp, 1985b; Whiteman, 1990) and those formed under intensely cold conditions such as the Barham Soil (Rose and Allen, 1977; Allen, 1983; Rose *et al.,* 1985b). These palaeosols appear to have a marked concentration in the south and east of Britain. They are particularly developed on river terrace gravels of the ancestral Thames and its tributaries, where they form important stratigraphical markers (Bridgland, 1994). Palaeosols are generally rare in northern England, although they occur in isolated pockets within the Lake District (Boardman, 1985c).

The red mottling in the Harwood Dale Moor soil is not characteristic of any geographically or stratigraphically adjacent geological formation and therefore must be regarded as a true pedological feature (Carroll and Bendelow, 1981). Red mottles previously reported in Britain are generally less concentrated and are confined to plateau drift in Hertfordshire, the Chilterns and Berkshire (Bullock *et al.,* 1973). Together with other pedological features in North Yorkshire, Bullock *et al.* (1973) have suggested that the Harwood Dale Moor palaeosol resembles those found in the modern tropical and subtropical areas where there is a marked wet and dry season. As there is currently no such distinct demarcation between wet and dry seasons in Britain, it seems reasonable to assume that the Harwood Dale Moor soil developed under a different climatic regime and therefore represents a true palaeosol. No independent dating control exists for this palaeosol, and its age remains uncertain.

Conclusions

The palaeosol features at Harwood Dale Moor provide important evidence of palaeoclimatic events in this area of northern England. Geochemical analysis suggests that the Harwood Dale Moor palaeosol formed under tropical or subtropical climatic conditions. The exact period of soil formation remains uncertain, but the pedogenesis may be of considerable antiquity. The location and preservation of the palaeosol is commonly taken as evidence that the North York Moors lay outside the maximum limits of the Dimlington Stadial ice sheet, but there also is the possibility that the palaeosol survives owing to selective erosion by the former ice sheet.

References



(Figure 4.32) The location of Harwood Dale Moor and its relationship to the Late Devensian ice sheet (after Bullock et al., 1973).