North Esk and West Water palaeochannels, Angus

[NO 570 690], [NO 585 685] and [NO 615 680]

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Highlights

The assemblage of outwash and river terraces at this site is particularly noted for its palaeochannels, which have allowed changing discharge patterns to be reconstructed since the time of deglaciation.

Introduction

This site comprises two areas in Strathmore located at the Highland edge near Edzell. The larger (*c.* 2.5 km^2) lies to the west of the village between [NO 565 695] and [NO 597 679]; the smaller (*c.* 0.6 km^2) to the south-east between [NO 614 686] and [NO 620 673]. Together, these areas are important for an assemblage of palaeochannels and associated deposits. These occur within an extensive spread of outwash (palaeosandur) deposits built out eastwards across Strathmore during the wastage of Late Devensian glaciers in the adjacent glens of the West Water and River North Esk (Synge, 1956; Sissons, 1967; Maizels, 1976; Gordon and McEwen, 1993).

The palaeosandur deposits associated with the North Esk and its tributary, the West Water, extend for 10 km downstream from the Highland Boundary Fault zone. They provide an excellent example of Late Devensian outwash deposits which have been dissected to form four main terrace systems. The terraces display systems of palaeochannels, which have been mapped in detail by Maizels (1976, 1983a,b), and used in palaeohy-drological reconstructions and modelling (Maizels, 1983a-c, 1986; Maizels and Aitken, 1991).

Description

In the valley of the West Water, 3 km west of Edzell, an area of hummocky kame and kettle topography and ice-contact slopes marks the position of a former glacier margin associated with the downwasting of the Late Devensian ice probably between 14 000 and 13 000 BP (Sutherland, 1984). Outwash terraces on a palaeosandur lead away from the former ice-front and extend out into Strathmore. As deglaciation progressed, the out-wash deposits and stream channels would have continued to adjust to changes in water discharge and sediment supply across the palaeosandur.

The palaeosandur deposits are up to 6 m in depth and are characterized as 'massive, coarse, poorly-sorted, imbricated gravels and cobbles, with isolated lenses of cross-bedded and plane-bedded coarse and medium sands, characteristic of Miall's (1978) "Gm" gravel lithofacies type, and similar to Scott outwash sediments (facies assemblage GII of Rust, 1978) comprising over 90% gravel content' (Maizels, 1983b, p. 256). The sedimentary characteristics of the sediments indicate deposition in an aggrading, proglacial, braided river environment (Maizels, 1983a).

The four main terraces, associated with both the North Esk and the West Water, have been mapped by Maizels (1983a,b) (Figure 2.52). The upper two terraces (T1 and T2) are evident only as isolated fragments; the lower two (T3 and T4) are much more extensive. Study has focused on the nature, direction and magnitude of change within this terrace sequence (Maizels, 1983a-c, 1986; Maizels and Aitken, 1991). For example, large-scale changes in channel pattern and morphology have been identified between terrace fragments and attributed to a decline in the amounts of meltwater discharge and sediment supplied during and after deglaciation.

The resulting palaeoforms thus reflect channel adjustment from a proglacial environment to present-day fluvial controls. They also demonstrate a southeastward migration of the North Esk/West Water confluence by 2.8 km; a shift that was clearly accompanied by periods of aggradation and incision.

As well as macro-scale change, more intricate localized channel incision and minor terrace fragments have been mapped. Three different types of palaeochannel have been identified, each type associated with different rates of discharge and sediment availability (Maizels, 1983a). These include complex braided systems (Type A), deeper wider channels (Type B), and deeply incised and relatively localized meander scars (Type C). In terms of inter-terrace variation in palaeochannel type, the two upper terraces have been identified as having more braided (Type A) and periglacial (Type B) channel systems, whereas the lower terraces have more sinuous (Type C) channels, although all terraces exhibit complex braided palaeochannels to a certain degree. The lower terraces (T3 and T4) are characterized by multiple channel networks, longitudinal bars, high width : depth ratios and low sinuosities. The lower terrace surfaces are also locally incised by relatively well-defined, deep, low-gradient, sinuous channels and many of the adjacent terrace bluffs possess major meander scars. The number of sinuous channels increases from the highest terrace (T1) to the lowest (T4), whereas the degree of braiding declines. Mean width-to-depth ratios decline from about 108 to about 40 between T1 and T4 (Maizels, 1983a).

Interpretation

Maizels (1983a,b) concluded that the deep, sinuous channels (Type C) were responsible for terrace formation and that each phase of terrace formation involved a change from straight, multiple channels to single-thread channels in response to threshold changes in meltwater and sediment discharges, which could relate to glacier fluctuations or episodic flood events. Base-level variations appear to have had only a minor effect on the channel adjustments.

As well as inter-terrace variation in palaeochannel type, both lateral and downstream intra-terrace changes have been identified. It is important to note, however, that many of the palaeochannel features are of low amplitude; the palaeochannel patterns are better viewed from the air, and are especially highlighted on infra-red aerial photographs. This site, with its extensive suite of palaeochannels in the terrace surfaces, thus provides a marked contrast to the well-defined suite of terraces with steep 'risers' along the River Findhorn (see report in this volume).

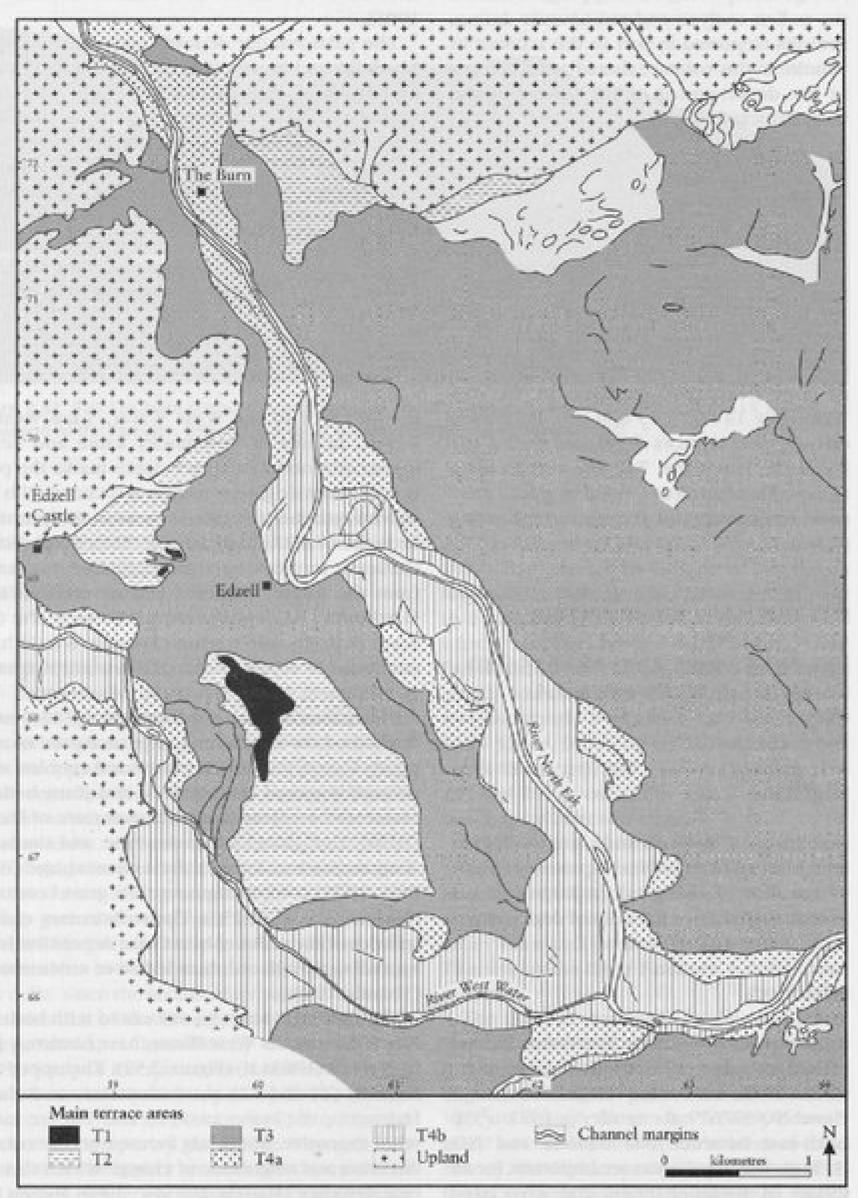
The present channel discharges are small compared with estimated palaeodischarges. In a series of studies, Maizels (1983a,b, 1986) has estimated velocities and discharges for particular palaeochan-nels, using empirical formulae (cf. Church, 1978; Ryder and Church, 1986). Peak flows calculated for the terrace sequence decreased from a maximum of *c.* 18 000 m^3s^{-1} on the highest terrace to *c.* 1300 m^3s^{-1} on the lowest. The decline in peak discharge to the present-day value of *c.* 330 m^3s^{-1} is thus as much as 50 times. At best, these values provide only order-of-magnitude estimates (cf. Maizels and Aitken, 1991).

The River North Esk and West Water site is particularly significant for the development of palaeochannels on the terrace surfaces. These features are among the best preserved of their type studied in Scotland and have allowed significant insights into the controls and thresholds governing channel change during and since deglaciation, particularly in relation to discharge and sediment supply. It is an important research site for assessing the extent of adjustments within the fluvial system since the Late Devensian in a lowland area with upland headwaters. Although Late Devensian palaeochannels are known to exist on terrace surfaces at other locations in Scotland — for example, along the River Dee (Maizels, 1985) and River Don (Maizels and Aitken, 1991), in Glen Feshie (Robertson-Rintoul, 1986a) and in the area south of Fraserburgh (British Geological Survey 1 : 50 000 Sheet 97) — these are generally less extensive and have not been studied in comparable detail to the North Esk and West Water features.

Conclusion

This site is important for understanding the formation of outwash and river terraces as the Late Devensian ice melted and wasted back into the Highland glens. The higher terraces record the former presence of the glacier, whereas the lower terraces are most notable for particularly good examples of fossil river channels. The latter provide valuable evidence for reconstructing the changes that occurred in river characteristics and behaviour during and following the period of ice melting.

References



(Figure 2.52) The terraces of the River North Esk and West Water in the Edzell area. (After Maizels, 1983a.)