CARLOPS

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Highlights

The landforms at Carlops comprise an outstanding assemblage of subglacial meltwater channels. These are particularly well developed and are noted for their anastomosing patterns.

Introduction

One of the most outstanding examples of meltwater channels in Scotland is located near Carlops, 21 km south-west of Edinburgh. The principal features extend over a distance of 3 km (from *c.* NT 140538 to NT 160557). The Carlops channels are part of an extensive glacial drainage system running south-west to north-east from the Clyde Valley to the Firth of Forth (see Sissons, 1967a, fig. 47; Price, 1973, fig. 43; Sutherland, 1984a, fig. 9) in which meltwater flow was concentrated through the gap between the Pentland Hills and Moorfoot Hills during the wastage of the Late Devensian ice sheet. The most detailed description of the channels at Carlops is that of Sissons (1963b) although the features were earlier mentioned by Milne Home (1840), MacLaren (1866), Day (1923), Charlesworth (1926b) and Eckford (1952).

Description

The channels to the south-west of Carlops (Figure 17.5) are cut in bedrock and range in depth from 1 m to over 20 m. In plan, they form an anastomosing pattern with a number of isolated rock "islands' occurring within the larger channels (for example, Windy Gowl) (Figure17.6). In profile, certain of the channels have "up and down' forms (ie. the floor of the channel first rises then falls in the former direction of the water movement), and there are numerous discordant junctions as well as channels that trend obliquely across slopes. Several of the channels cut across the present drainage divides. Sissons (1963b) noted that certain of the channels were aligned along faults, but not all faults are followed by channels and many channels are not apparently fault-guided, so the principal controls on channel location may be presumed to be topographical and glaciological. To the north-east ofCarlops, the channels cut into an area of glaciofluvial deposition and join the major meandering channel, over 30 m deep, which is now occupied by the River North Esk. In this area, Sissons (1963b) was able to demonstrate that there is an ancient channel, which pre-dates the last glaciation, below the drift deposits and which largely controls the direction of the subsequent drainage.

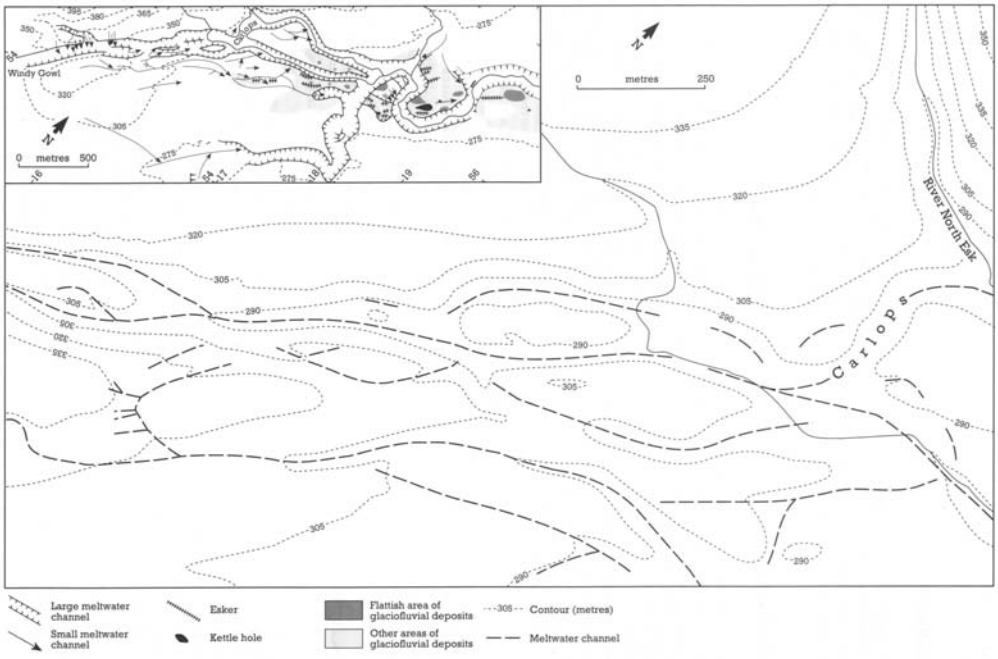

Figure 17.5: The meltwater channel system at Carlops. The detailed pattern of channels immediately to the south-west of the village (main diagram) forms part of a more extensive glacial drainage system represented by channels and glaciofluvial deposits (inset) (from Sissons, 1963b).

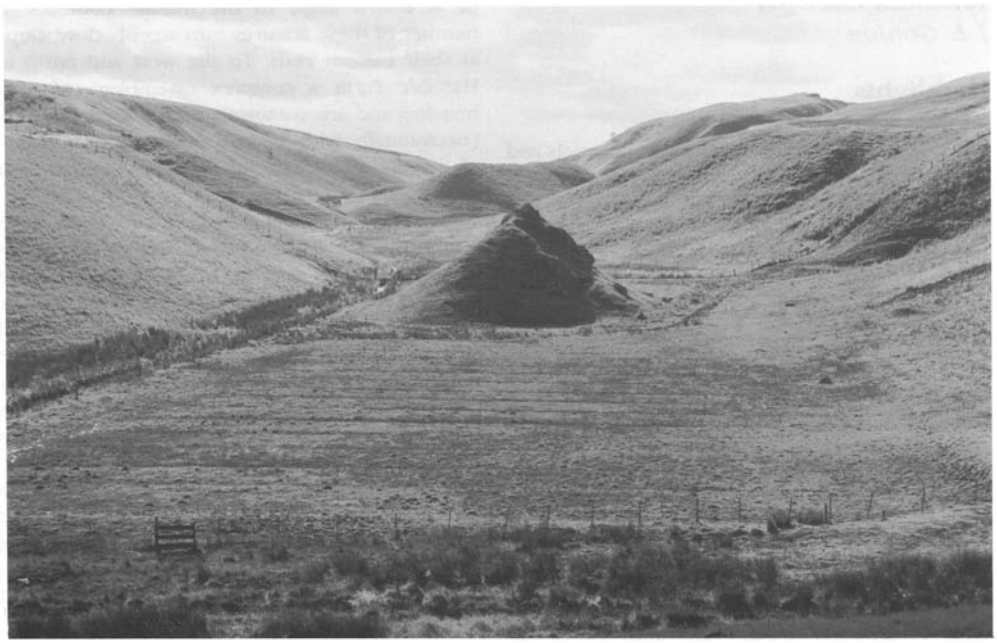

Figure 17.6: The main meltwater channel at Carlops showing the anastomosing form of the channel system and the isolated interfluve 'islands' between constituent channels. (Photo: J. E. Gordon.)

Interpretation

The general alignment of the channels is in the SW–NE direction of flow of the last ice to cover the Carlops area, this direction being indicated by both striations and ice-moulded drift and bedrock ridges along the foot of the Pentland Hills. Charlesworth (1926b) considered that this ice originated in the Highlands and had recurved around the south of the Pentland Hills, but the erratic content of the local drift, particularly the presence of Tinto felsite (McCall and Goodlet, 1952), clearly indicates that the last ice originated in the Southern Uplands (see Sutherland, 1984a, figure 6). It is notable that the Carlops channels occur on the highest part of the

meltwater drainage system between the River Clyde and the Firth of Forth and that, to both the south-west and the north-east, the drainage system is dominantly represented by glaciofluvial depositional features (see Carstairs Kames). Such a spatial pattern accords broadly with that predicted in the model of Sugden and John (1976) for meltwater flow across irregular topography under active, warm-based ice. The model, based on Shreve's (1972) analysis of the variations in the pressure gradient that drives subglacial meltwater flow, predicts erosion across the crests and immediately on the lee sides of divides, and deposition on intervening lower ground.

Charlesworth (1926b) interpreted the major Windy Gowl channel at Carlops as ice marginal in origin; Eckford (1952) thought it to be a lake overflow, with the reversed slope on part of it being formed by post-glacial stream erosion. Sissons (1963b), however, showed these interpretations to be invalid. He argued that the forms, positions and relationships of the channels and glaciofluvial deposits were indicative of a subglacial origin through superimposition of an englacial stream system on to the underlying topography, an interpretation supported by Price (1973). In the overall evolution of the system, Sissons envisaged a progressive change from subglacial to open ice-walled to proglacial drainage as the ice sheet downwasted and the Carlops area became ice free.

The features at Carlops are classic landforms which demonstrate strikingly the morphology of subglacial meltwater channels. They illustrate very clearly the anastomosing pattern of subglacial meltwater flow and the hydraulic gradient reflected in the "up and down' channel profiles. The Carlops channels are representative of the ice-directed type of meltwater channel (*cf.* Sugden and John, 1976) and in this respect are similar to certain of the channels in the Cairngorms, at Muir of Dinnet and at Rammer Cleugh. In contrast to these other areas, they demonstrate particularly well an anastomosing subglacial meltwater flow pattern. Further, in their overall pattern, the Carlops channels differ from the channel systems in the Cairngoms and at Muir of Dinnet, where they formed in sub-marginal positions in association with a progressively downwasting ice sheet. The Carlops channels are also part of a much more extensive system of meltwater landforms formed during the retreat of the Late Devensian ice sheet and hence are important in a regional context for reconstructing the pattern of glacial meltwater drainage.

Conclusions

Carlops is important for glacial geomorphology. It is an outstanding example of a subglacial meltwater channel system that formed beneath the last ice sheet. It is particularly noted for the fine development of the individual channels which include a variety of anastomosing forms. The Carlops channels form part of a wider regional pattern of glacial meltwater drainage that developed during the melting of the last ice sheet (around 14,000 years ago).

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