Llyn Peris

Highlights

This is a classic site for the study of small-scale glacial and fluvioglacial erosional features. Glaciated striated pavements hereabouts have been studied since the earliest Victorian workers realised the significance of such phenomena in relation to the action of glacier ice.

Introduction

The shores of Llyn Peris are important for exceptionally fine examples of glaciated bedrock surfaces and small-scale forms of glacial erosion. Although it is some 13,000 years at least since the area was last glaciated, features including glacial striae, friction cracks, sichelwannen and sinuous grooves and channels have been remarkably well preserved from subaerial weathering beneath the lake waters. Glacial striae were first described in the Llanberis Valley by Ramsay (1860, 1881), and the late-glacial and Holocene deposits of the Peris-Padarn area were described by Tinsley and Derbyshire (1976) and Derbyshire (1977). A detailed account of the glacial erosional forms at Llyn Peris was given by Gray (1982b) and similar features in adjacent areas were described by Gray and Lowe (1982). The site was mentioned by Addison (1983) in an account of the classic glacial landforms of Snowdonia, and has also featured in a study of ice movement directions (Gemmell *et al.* 1986).

Description

The existence of well developed glacial erosional features, including roches moutonnées and glacial striae, has long been known from the Llanberis Pass in Snowdonia. As long ago as 1860, Ramsay described the distribution of striae in the Llanberis Valley and interpreted the former directions of ice movement. Recent construction of the Dinorwic hydro-electric power scheme has afforded a rare opportunity to study unweathered glaciated bedrock. During construction work, the lake levels were lowered both in the upper lake of the storage scheme (Marchlyn Mawr) and in the lower reservoir at Llyn Peris. The small-scale erosional features exposed at these sites have been described by Gray and Lowe (1982) and Gray (1982b).

Llyn Peris and Llyn Padarn occupy an over-deepened basin towards the lower end of the Llanberis glacial trough. There was once one lake but this was divided by an alluvial fan near Pont-y-Bala. At both ends of Llyn Peris, boreholes reveal considerable depths of sediment — lake rhythrnites, sands, gravels, organic lake muds, wood debris and peat (Tinsley and Derbyshire 1976; Derbyshire 1977). Cambrian slate and sandstone bedrock, preserving a wide range of glacial erosional features is exposed along the lake margins. Gray's (1982b) description of the site pertains to the low lake levels experienced during construction of the HEP scheme, although substantial areas of glaciated bedrock are still visible even at relatively high lake levels.

Three chief areas of exposed bedrock bear significant evidence for glacial and fluvioglacial erosion processes. The first lies on the north shore of Llyn Peris at the eastern end of the lake [SH 599 591]; the only stretch of the north shore not obscured by slate spoil. The bedrock surface here is heavily abraded and striated. Large, steeply sloping slabs of slate up to 10m high show that ice moved upwards against these obstacles at angles of 5–10°, and abraded lee slopes in this area frequently show a conspicuously stepped appearance as a result of rapid changes in lithological composition. Smoothed cavities on lee slopes can also be seen, and these bear witness to fluvioglacial smoothing in cavities beneath the ice. The unusual feature of a trench following an igneous dyke occurs at this site. The trench, 11.5m deep, runs transverse to the valley and the main down-valley trend of the striae. The trench also carries striae parallel to its trend.

The second main glaciated bedrock area, bearing a similar range of features, stretches along the southern shore between [SH 597 589] and [SH 589 594], and a smaller area carrying comparable features occurs on the shores below Dolbadarn Castle [SH 588 597] to [SH 586 599]).

Interpretation

The Llanberis trough was probably last glaciated during the Late Devensian, and a series of radiocarbon dates from deposits at Pont-y-Bala and East Peris (Shotton *et al.* 1975; Tinsley and Derbyshire 1976) dates the thick sediment sequence to the Devensian late-glacial and the Holocene. The basin could not therefore have been glaciated during the Younger Dryas, and the erosional features described by Gray (1982b) from Llyn Peris were most probably caused by Late Devensian ice.

Gray (1982b) considered that abraded bedrock was the most striking feature of the floor of Llyn Peris, noting that the homogenous fine-grained slate was particularly susceptible to subglacial scratching and polishing. He measured the orientations of striae at a number of locations on flat bedrock surfaces, confirming the expected down-valley trend of ice movement. However, small deviations of movement were also recorded, showing that the ice had changed direction as it moved north-west along the trough. In particular, once the ice had passed the steep confining slopes below Gweithdy [SH 593 590], it appears to have swung into the bay on the south-west shore as it became less constricted, moving into the wider valley where Llanberis is now situated. Other smaller-scale features influencing striae trends were also noted, including the trench running transverse to the main trend of the striae (with striae in the trench running parallel to the orientation of the trench), and several linear joint-controlled grooves bearing curved striae. These features appear to have controlled locally the streaming of basal ice and debris layers. Differential erosion had occurred as a result of lithological changes and jointing, as well as in response to the local occurrence of iron pyrite crystals which had caused small-scale 'crag and tail' forms (Gray 1982b).

Gray also described irregularly-shaped transverse marks at Llyn Peris, which had given the rock surface at many localities a rough appearance perpendicular to ice movement, probably as the result of bedrock fracture or crushing. Other locations were described where fracturing and plucking had been facilitated by cleavage and jointing in the slate.

The role of meltwater in eroding the bedrock surface was discussed by Gray: many sharp edges had been rounded off, and smoothed 'lee' faces with small shallow bowls were also commonly displayed. Because such features resembled meltwater-produced forms observed in cavities beneath the glacier d'Argentiere in the French Alps (Vivian and Bocquet 1973), Gray considered this was also probably the most likely mechanism for widespread smoothing of lee slopes at Llyn Peris.

Other erosional forms including features resembling sichelwannen (Sugden and John 1976, figure 15.1) and sinuous channels and grooves with striated floors were described by Gray from Llyn Peris. The latter were likened to 'p-forms' studied by Gray (1981) on Mull, which he considered had resulted from meltwater corrasion and/or cavitation, with active ice later moving through the channels to striate them. The processes of till squeezing, the movement of till as a semi-saturated mass under pressure beneath the ice (Gjessing 1965), or direct glacial abrasion (Boulton 1974) were also considered as alternative explanations.

Llyn Peris shows some of the finest glaciated bedrock surfaces in Britain. Examples of abrasion, bedrock fracture, plucking and meltwater erosion are found at the site, including a great diversity of typical small-scale erosional features such as striae and friction cracks. The interest of the site is enhanced by the presence of possible sichelwannen features and sinuous grooves and channels, perhaps formed by subglacial meltwater. Recent studies of the assemblage of features at Llyn Peris have shown that the standard view of glacial bedrock erosion occurring by the twin processes of 'abrasion' and 'plucking' is an oversimplification. From evidence at Llyn Peris, it is clear that bedrock fracture, particularly in highly-cleaved rocks, and meltwater erosion are also important processes. The process of erosion by the squeezing of subglacial till may also have contributed to the formation of some features.

Conclusions

The wide range of small-scale erosional features displayed at Llyn Peris and their remarkable state of preservation, make the site probably the finest of its kind in Britain and of exceptional interest to geomorphologists. The site provides a unique opportunity, in a country that has no present-day glaciers, to study former glacial and fluvioglacial erosion

processes and resultant bedrock forms.

References