BEINN ALLIGIN

J.E. Gordon

OS Grid Reference: NG870595

Highlights

The principal interest at Beinn Alligin is a large rockslide which occurred on to the surface of a glacier during the Loch Lomond Stadial. It is the largest and clearest such feature in Britain and illustrates the geomorphological effects of high-magnitude slope failure in a glacial environment.

Introduction

Beinn Alligin (NG 870600) is located on the north side of Loch Torridon in a highly dissected landscape of glacial erosion and narrow mountain ridges. On its north-west and south-east sides the mountain is indented by corries, which acted as ice source areas for Loch Lomond Readvance glaciers (Sissons, 1977a). The most impressive corries are those of Toll a'Mhadaidh M¢r and Toll a'Mhadaidh Beag, which together with Coire Mhic Nòbuil demonstrate a fine range of glacial and mass-movement landforms, including most notably an extensive area of glacially transported rock slope failure (rockslide or rock avalanche) debris that has been interpreted as constituting the largest fossil rock glacier in Scotland. Its characteristics and origin are described in detail by Sissons (1975a) and discussed by Sissons (1976d, 1977d), Whalley (1976a) and Ballantyne (1987c). In addition, lateral, medial and hummocky moraines are well represented.

Description

The rock slope failure debris in Toll a'Mhadaidh M¢r (Figures6.11 and 6.12) comprises a massive accumulation of Torridonian sandstone blocks, some exceeding 5 m in length, that form a debris tongue 1.2 km long, up to 15 m high and tapering in width from 400 m at the head to 200 m near the toe. At the surface, the debris mass displays both longitudinal and transverse ridges and depressions. The lowermost 300–400 m of the debris tongue is much less thick than the rest (Figure 6.12). The source of the debris is marked by a large scar and cleft high on the corrie headwall below the summit of Sgùrr Mh¢r. In part, the scar is structurally defined by two intersecting faults.

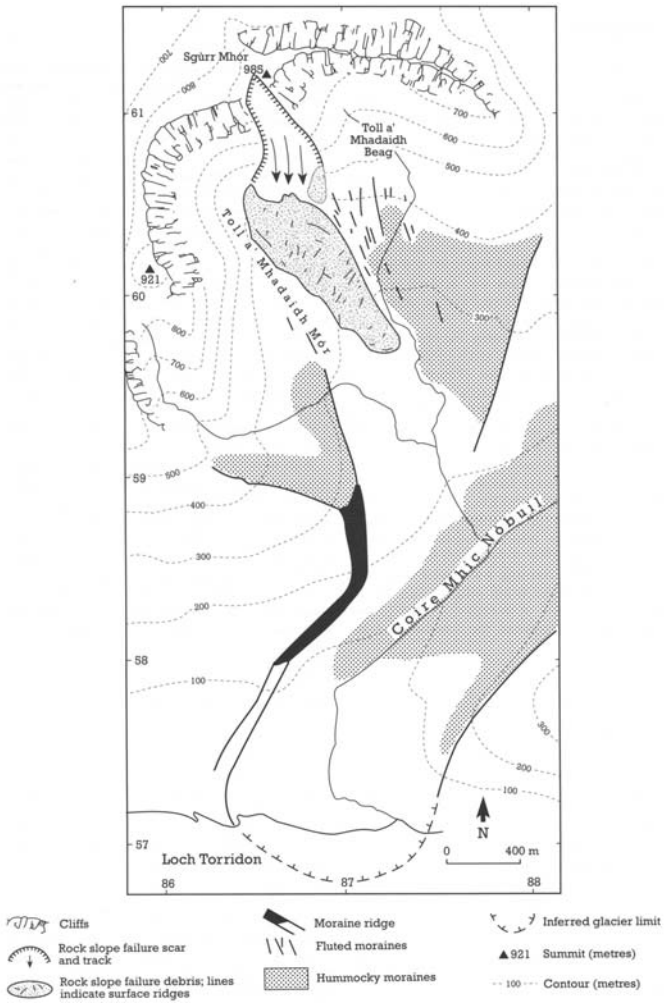

Figure 6.11: Geomorphology of Toll a'Mhadaidh, Beinn Alligin, showing rockslide debris and principal glacial landforms (from Sissons, 1977d).

Figure 6.12: Beinn Alligin, a Torridonian sandstone mountain in Wester Ross, rises above an ice-scoured surface of Lewisian gneiss to the west. A lateral moraine (centre left) marks the limit of a Loch Lomond Readvance glacier and is succeeded on the lower slopes by hummocky moraine; fluted drift can also be seen in the centre and to the right of the photograph. A large rock avalanche scar is prominent below the summit of Sǵurr Mhór. The resulting deposit on the corrie floor includes a low tongue of boulders extending beyond the main part of the deposit. (Cambridge University Collection: copyright reserved.)

Beinn Alligin is also notable for fine examples of double lateral moraines and a medial moraine of Loch Lomond Stadial age (Figures 6.11 and 6.12). The lateral moraines are well-developed on both sides of Coire Mhic Nòbuil and mark the limit of a Loch Lomond Readvance glacier which extended just offshore into Loch Torridon (Sissons, 1977a). In places double ridges are present. Sections in the western lateral moraine along the Diabaig road reveal boulders and cobbles in a sandy-gritty matrix; upslope from here the lateral moraine comprises boulder ridges. The medial moraine in Coire Mhic Nòbuil is clearly seen as a line of boulders running south-west from the northern limb of the Beinn Alligin ridge. On its western side a zone of hummocky moraine and fluted moraine completes the landform assemblage.

Interpretation

Beinn Alligin provides a particularly striking illustration of a major rock slope failure apparently associated with glacier ice, although there are varying interpretations of the resulting deposits.

Sissons (1975a) considered that the debris accumulation in Toll a'Mhadaidh M¢r was not simply a landslide deposit, since several aspects of its morphology are quite unlike those of other rockslides in the Highlands, notably its sharply defined lateral margins and long travel distance. Certain of its morphological characteristics, however, are similar to those of rock glaciers elsewhere: plan shape, transverse ridges and closed depressions. Sissons considered that the feature represented reactivation of a small decaying glacier in the corrie by a rockslide during the Loch Lomond Stadial.

As an alternative explanation, Whalley (1976a) put forward the hypothesis that the feature was simply a rockslide deposit, with only a morphological resemblance to a rock glacier from which any ice had melted (*cf.* Whalley and Martin, 1992). He argued that its characteristics are typical of many large features of this kind and could relate to either flotation on a cushion of air (Shreve, 1968a, 1968b) or the development of particular flow properties that aid momentum transfer (Hsü, 1975; Eisbacher, 1979; Cruden and Hungr, 1986). In reply, Sissons (1976d) contended that topographic conditions at Beinn Alligin did not favour airborne flow and that the form of the debris tongue differed in certain respects from rockslides that apparently moved in this way. In particular, it lacks the highly distinctive lateral and distal rims and surface fluting typical of many large-scale rock avalanches or flowslide deposits (Shreve, 1966, 1968a, 1968b; Marangunićc and Bull, 1964; Reid, 1969; Hsü, 1975; Gordon *et al.*, 1978).

Ballantyne (1987c) accepted that the Beinn Alligin deposit is a glacially transported rockslide or rock avalanche, but noted that it lacked the steep front and high terminal ridges typical of rock glaciers and that the debris thinned downslope. He therefore suggested that the glacier may have been larger than envisaged by Sissons (1975a) and that a rock glacier in the normal sense may not have formed (i.e. through the deformation of an ice core or interstitial ice within the debris). Accordingly, the Beinn Alligin feature may resemble several modern instances of rockslides or rock avalanches on to glaciers (Maranguni{cacute;c and Bull, 1964;Reid, 1969; Gordon *et al.*, 1978).

Glacially transported rock slope failure deposits have been reported elsewhere in Scotland, for example on Eigg (Peacock, 1975d) and in Gorm Coire, Ben Hee (Haynes, 1977b). None of these, however, rivals the Beinn Alligin feature in terms of size, or clarity of the relationship between source and transported debris. Holmes (1984) has established that the great majority of rock slope failures in the Highlands occur within a short distance of the former limits of Loch Lomond Readvance glaciers, and he suggested that excess pore water pressures developing in oversteepened slopes during deglaciation may have contributed significantly to subseqent slope failure (*cf.* Whalley, 1974; Whalley *et al.*, 1983).

Elsewhere in Scotland, fossil rock glaciers have been described from Beinn Shiantaidh on Jura (Dawson, 1977) and the Cairngorms (Sissons, 1979f; Ballantyne, 1984; Chattopadhyay, 1984). They are all smaller features, however, and differ in their morphology and inferred mode of formation, as they take the form of protalus lobes (see Wahrhaftig and Cox, 1959; LiestØl, 1961; Outcalt and Benedict, 1965; White, 1976; Lindner and Marks, 1985; Martin and Whalley, 1987; Whalley and Martin, 1992) that have apparently developed as a result of deformation of ice within rockfall talus accumulations. The only other features in Britain that may be of similar origin to that at Beinn Alligin are at Moelwyn Mawr in North Wales (Campbell and Bowen, 1989) and Beinn an Lochain in Argyll (Holmes, 1984; Maclean, 1991).

Although good examples of the different types of Loch Lomond Readvance moraine represented at Beinn Alligin occur both individually and in various combinations at other sites in the Highlands, the Beinn Alligin landforms provide a particularly fine assemblage which enhances the overall geomorphological value of the site. Further, the medial moraine in Coire Mhic Nòbuil was described by Sissons (1977a) as the "best individual example' in the area of the northern Highlands that he had mapped.

Conclusions

Beinn Alligin is noted for a large rockslide transported by a glacier. Although it has been interpreted as a fossil rock glacier, the largest such feature in Scotland, several lines of evidence suggest that it comprises a rockslide from the corrie headwall, which accumulated on the surface of a glacier during the intensely cold phase known as the Loch Lomond Stadial (about 11,000–10,000 years ago). The site is important in illustrating the geomorphological impact of high-magnitude slope processes during the stadial, and it also shows the problems of interpreting the origins of fossil landforms from morphological evidence alone. The wider landform assemblage also includes good examples of different types of moraines.

Reference list

Ballantyne, C.K. (1984) The Late Devensian periglaciation of upland Scotland.*Quaternary Science Reviews*, **3**, 311–43.

Ballantyne, C.K. (1987c) The Beinn Alligin `rock glacier'. In*Wester Ross Field Guide* (eds C.K. Ballantyne and D.G Sutherland). Cambridge, Quaternary Research Association, 134–7.

Campbell, S. and Bowen, D.Q. (1989) *Quaternary of Wales*. *Geological Conservation Review*. Peterborough, Nature Conservancy Council, 237pp.

Chattopadhyay, G.P. (1984) A fossil valley-wall rock glacier in the Cairngorm mountains. *Scottish Journal of Geology*, **20**, 121–5.

Cruden, D.M. and Hungr, O. (1986) The debris of the Frank Slide and theories of rockslide-avalanche mobility. *Canadian Journal of Earth Sciences*, **23**, 425–32.

Dawson, A.G. (1977) A fossil lobate rock glacier in Jura.*Scottish Journal of Geology*, **13**, 37–42.

Eisbacher, G.H. (1979) Cliff collapse and rock avalanches (sturzstroms) in the Mackenzie Mountains, north-western Canada. *Canadian Geotechnical Journal*, **16**, 309–34.

Gordon, J.E., Birnie, R.V. and Timmis, R. (1978) A major rockfall and debris slide on the Lyell Glacier, South Georgia. *Arctic and Alpine Research*, **10**, 49–60.

Haynes, V.M. (1977b) Landslip associated with glacier ice.*Scottish Journal of Geology*, **13**, 337–8.

Holmes, G. (1984) Rock slope failure in parts of the Scottish Highlands. Unpublished PhD thesis, University of Edinburgh.

Lindner, L. and Marks, L. (1985) Types of debris slope accumulations and rock glaciers in south Spitsbergen. *Boreas*, **14**, 139–53.

Maclean, A.F. (1991) The formation of valley-wall rock glaciers. Unpublished PhD thesis, University of St. Andrews.

Martin, H.E. and Whalley, W.B. (1987) Rock glaciers. Part 1: rock glacier morphology, classification and distribution. *Progress in Physical Geography*, **11**, 260–82.

Outcalt, S.I. and Benedict, J.B. (1965) Photo-interpretation of two types of rock glacier in the Colorado Front Range, USA. *Journal of Glaciology*, **5**, 849–56.

Peacock, J.D. (1975d) Landslip associated with glacier ice.*Scottish Journal of Geology*, 11, 363–5.

Reid, J.R. (1969) Effects of a debris slide on 'Sioux Glacier', south-central Alaska.*Journal of Glaciology*, **8**, 353–67.

Shreve, R.L. (1966) Sherman landslide, Alaska.*Science*, **154**, 1639–43.

Shreve, R.L. (1968a) The Blackhawk Landslide.*Geological Society of America Special Paper*, **108**, 47pp.

Shreve, R.L. (1968b) Leakage and fluidization in air-layer lubricated avalanches.*Bulletin Geological Society of America*, **79**, 653–8.

Sissons, J.B. (1975a) A fossil rock glacier in Wester Ross.*Scottish Journal of Geology*, **11**, 83–6.

Sissons, J.B. (1976d) A fossil rock glacier in Wester Ross. Reply to W.B. Whalley.*Scottish Journal of Geology*, **12**, 178–9.

Sissons, J.B. (1977a) The Loch Lomond Readvance in the northern mainland of Scotland. In *Studies in the Scottish Lateglacial Environment* (eds J.M. Gray and J.J. Lowe). Oxford, Pergamon Press, 45–59.

Sissons, J.B. (1979f) The Loch Lomond Advance in the Cairngorm Mountains.*Scottish Geographical Magazine*, **95**, 66–82.

Wahrhaftig, C. and Cox, A. (1959) Rock glaciers in the Alaska Range.*Bulletin of the Geological Society of America*, **70**, 383–436.

Whalley, W.B. (1974) *The mechanics of high-magnitude*, *low frequency rock failure and its importance in a mountainous area*. *University of Reading*, *Department of Geography*, *Geographical Papers*, No. **27**, 48pp.

Whalley, W.B. (1976a) A fossil rock glacier in Wester Ross.*Scottish Journal of Geology*, **12**, 175–8.

Whalley, W.B. and Martin, H.E. (1992) Rock glaciers: II models and mechanisms.*Progress in Physical Geography*, **16**, 127–86.

Whalley, W.B., Douglas, G.R. and Jonsson, A. (1983) The magnitude and frequency of large rockslides in Iceland in the Postglacial.*Geografiska Annaler*, **65A**, 99–110.

White, S.E. (1976) Rock glaciers and block fields, review and new data.*Quaternary Research*, **6**, 77–97.