
COIRE A'CHEUD-CHNOIC

J.E. Gordon and D.G. Sutherland

OS Grid Reference: NG955550

Highlights

This outstanding geomorphological locality is noted for its assemblage of hummocky moraines formed during the Loch Lomond Stadial. These deposits provide important evidence for the processes of glacier activity and waste.

Introduction

Coire a'Cheud-chnoic (Valley of a Hundred Hills) (NG 955550) in Glen Torridon, is a classic geomorphological locality displaying one of the best and most accessible examples of hummocky moraine in Scotland. The moraines were first mentioned by Geikie (1863a) in a footnote (p. 157) reporting "a vast but unrecorded accumulation of glacier mounds blocking up a glen between Loch Torridon and Loch Maree", and a plate of the valley, first published in the Geological Survey memoir (Peach *et al.*, 1913b), has been reproduced in standard texts such as Wright (1937) and Sissons (1967a). Despite the clarity of development of the moraines little research was carried out on the area until recent years when Robinson (1977) mapped their distribution and Hodgson (1982, 1987) carried out sedimentological and morphological studies to ascertain the genesis of the features.

Description

Coire a'Cheud-chnoic drains into Glen Torridon from the south-east and is underlain by Torridonian sandstone and north-east aligned belts of Cambrian Quartzite. The greater part of the valley floor is covered by hummocky moraines which reach 8 m in height. Areas of bedrock crop out, implying that there is no great thickness of till under the moraines. Although they have a chaotic appearance, mapping of the moraines by Hodgson (1982, 1987) has shown that, in the lower valley, the majority of the moraines are elongated in a roughly north-south direction (in conformity with striations on the neighbouring bedrock surfaces) (Figure 6.13). Many of the moraines are asymmetric in long profile, with the highest part at the northern end, which gives them a conical appearance when viewed from Glen Torridon (Figure 6.14).

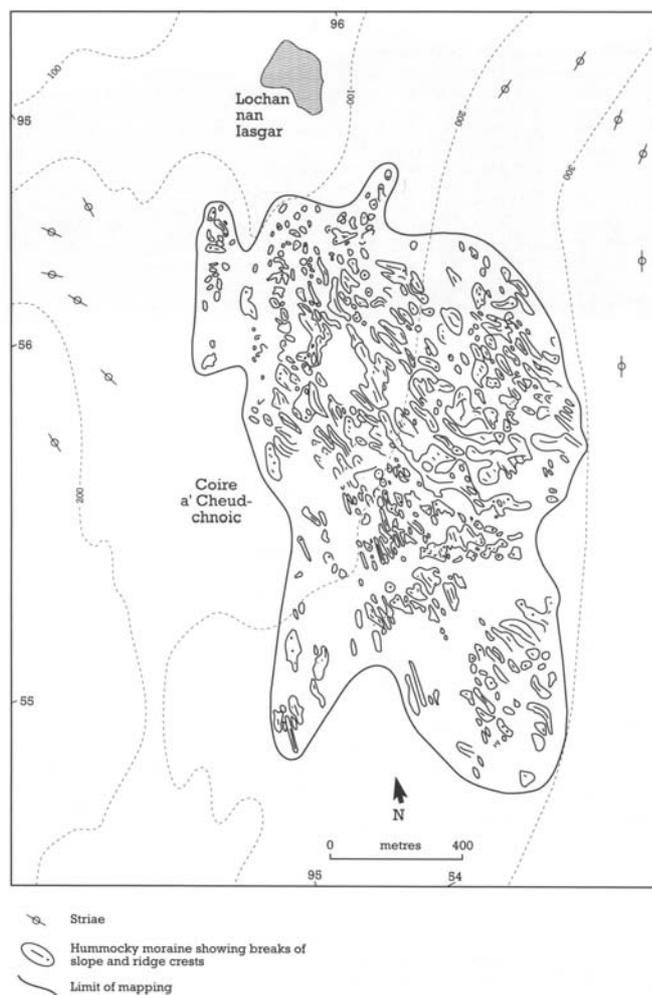


Figure 6.13: Geomorphology of Coire a'Cheud-chnoic (from Hodgson, 1987).



Figure 6.14: Hummocky moraine at Coire a'Cheud-chnoic in Glen Torridon. A clear drift limit on the valley side demarcates the Loch Lomond Readvance deposits below from the ice-scoured bedrock slopes above. (British Geological Survey photograph D2737.)

Constituent materials of the hummocky moraine are revealed in a recent roadside quarry at NG 954567. The section shows till at the bottom, consisting of angular clasts and boulders in a sandy and gritty matrix. Its upper surface is deformed, and an overturned fold partly encloses a large lense of poorly bedded sands and gravels. Above, layers of sands and gravels form the core of the upper section of the mound. The depression adjacent to it is underlain by a semicircular lens of angular clasts in a gravel and grit matrix, and is capped by a layer of poorly sorted sands and gravels. It is not possible to assess how representative this section is

of the hummocky moraine as a whole, although Hodgson (1982, 1987) showed that the moraines elsewhere are composed of till and that there is little vertical variation in either particle size or erratic content. He found that the majority of the moraine mounds were elongated in a north–south direction and that the clast fabrics had a primary orientation mode parallel to the long axis of the moraines. Although quartzite underlies all the steep ground above the valley, it represents only a small proportion of the surface boulders on the moraines, implying that supraglacially derived debris from the valley sides was not a significant source of the debris. Instead, a significant portion of the erratic content of the moraines is material that was introduced into the area during the Late Devensian ice-sheet glaciation. The mapping of Robinson (1977, 1987a) and Sissons (1977a) has demonstrated that the moraines in Coire a'Cheud-chnoic were formed during the Loch Lomond Readvance.

Interpretation

Hodgson (1982, 1987) concluded that, since the moraines were dominantly composed of exotic material but had been formed by glaciers that were confined to the local valley system, then the moraines were the result of a Loch Lomond Readvance glacier overriding and partially deforming pre-existing debris into a crude type of fluted moraine. He considered that such an explanation could be applied more widely to hummocky moraine in the Highlands of Scotland, although he cited only one particular study, that of Donner and West (1955) on Skye (see the Cuillin), which apparently described similar moraines. Detailed studies elsewhere in Torridon supported his contention that the fluted moraine had formed by subglacial deformation of the sediments (Hodgson, 1982, 1986).

Hummocky moraine occurs widely in the Highlands, Inner Hebrides and parts of the Southern Uplands (see, for example, Geikie, 1863a; Geikie, 1901; Bailey *et al.*, 1924; Peacock, 1967; Sissons, 1967a, 1977a; Gray and Brooks, 1972; Sissons *et al.*, 1973; Bennett, 1991), but its best development in the British Isles is in north-west Scotland (Sissons, 1976b). The Torridon area contains some particularly notable examples, especially to the north of Beinn Eithe and Liathach (Sissons, 1977a; Hodgson, 1982). The moraines of Coire a'Cheud-chnoic are especially significant, both as a representative example of these landforms in the Torridon area and as an area on which detailed research has been carried out into their mode of formation. The locality is also well-known because of its use as a text-book illustration.

Despite considerable documentation of the location of hummocky moraine and some controversy over its implications for the reconstruction of former ice margins (see the Cairngorms), there have been few detailed studies of its origin until recently. Three main explanations have been proposed (see also Loch Skene and the Cuillin). First, it may be a type of chaotic, "dead-ice" topography formed by rapid stagnation of ice that carried an extensive cover of supraglacial debris (Sissons, 1967a; Thompson, 1972). Second, it may be produced by controlled or uncontrolled deposition by actively retreating glaciers (Eyles, 1979, 1983; Day, 1983; Horsfield, 1983; Benn, 1990, 1991; Bennett, 1990, 1991; Bennett and Glasser, 1991) (see the Cairngorms). Third, as demonstrated by Hodgson (1982, 1987) for the Coire a'Cheud-chnoic features, it may be a subglacial deposit formed by deformation of pre-existing till (see also the Cuillin; Ballantyne, 1989a, Benn, 1991). Probably all three types exist, often in a single area (as in the Cuillin and at Loch Skene), but their relative importance is generally unknown. As the focus of a detailed case study, Coire a'Cheud-chnoic is therefore an important reference locality for wider comparative investigations of the genesis of the different landform types that appear to comprise hummocky moraine. The results of such work may have a significant bearing on interpreting styles of deglaciation and recognition of diagnostic landform and sediment facies assemblages (see Eyles, 1979, 1983; Sharp, 1985; Evans, 1989; Benn, 1990, 1991; Benn *et al.*, 1991; Bennett, 1991). The distribution patterns of hummocky moraine types, when compared with reconstructed glacier margins, flowlines and debris sources, should provide important information on sediment transfer controls and glacier processes during the Loch Lomond Readvance (*cf.* Benn, 1989b for end moraines). Further, if the subglacial origin of the Coire a'Cheud-chnoic deposits is confirmed, then the site can provide important field evidence for inputs to models of glacier dynamics for deformable bed materials (see Boulton and Jones, 1979; Alley *et al.*, 1986; Boulton and Hindmarsh, 1987).

Conclusions

Coire a'Cheud-chnoic is a classic geomorphological locality for an assemblage of hummocky moraines formed by a glacier during the Loch Lomond Stadial (about 11,000–10,000 years ago). It is one of the best locations in Scotland showing this type of glacial deposit, the form and distribution of which are important for interpreting the mode and pattern of ice wastage.

Reference list

- Alley, R.B., Blankenship, D.D., Bentley, C.R. and Rooney, S.T. (1986). Deformation of till beneath ice stream B, West Antarctica. *Nature*, **322**, 57–9.
- Bailey, E.B., Clough, C.T., Wright, W.B., Richey, J.E. and Wilson, G.V. (1924) *Tertiary and Post-Tertiary Geology of Mull, Loch Aline and Oban*. (A description of parts of Sheets 43, 44, 51, and 52 of Geological Map). Memoirs of the Geological Survey of Scotland. Edinburgh, HMSO, 445pp.
- Ballantyne, C.K. (1989a) The Loch Lomond Readvance on the Isle of Skye, Scotland; glacier reconstruction and palaeoclimatic implications. *Journal of Quaternary Science*, **4**, 95–108.
- Ballantyne, C.K. (1989b) Avalanche impact landforms on Ben Nevis, Scotland. *Scottish Geographical Magazine*, **105**, 38–42.
- Benn, D.I. (1989b) Debris transport by Loch Lomond Readvance glaciers in northern Scotland: basin form and within-valley asymmetry of lateral moraines. *Journal of Quaternary Science*, **4**, 243–54.
- Benn, D.I. (1990) Scottish Lateglacial moraines: debris supply, genesis and significance. Unpublished PhD thesis, University of St Andrews.
- Benn, D.I. (1991) Glacial landforms and sediments on Skye. In *The Quaternary of the Isle of Skye: Field Guide* (eds C.K. Ballantyne, D.I. Benn, J.J. Lowe and M.J.C. Walker). Cambridge, Quaternary Research Association, 35–67.
- Bennett, M.R. (1990) The deglaciation of Glen Croulin, Knoydart. *Scottish Journal of Geology*, **26**, 41–6.
- Bennett, M.R. (1991) Scottish 'hummocky moraine': its implications for the deglaciation of the north west Highlands during the Younger Dryas or Loch Lomond Stadial. Unpublished PhD Thesis, University of Edinburgh.
- Bennett, M.R. and Glasser, N.F. (1991) The glacial landforms of Glen Geusachan, Cairngorms: a reinterpretation *Scottish Geographical Magazine*, **107**, 116–23.
- Boulton, G.S. and Hindmarsh, R. (1987) Sediment deformation beneath glaciers: Theology and geological consequences. *Journal of Geophysical Research*, **92**, 9059–82.
- Boulton, G.S. and Jones, A.S. (1979) Stability of temperate ice caps and ice sheets on beds of deformable sediment. *Journal of Glaciology*, **24**, 29–42.
- Day, T.E. (1983) The remanent magnetism of till and other glacial sediments. Unpublished PhD thesis, University of East Anglia.
- Donner, J.J. and West, R.G. (1955) Ett drumlinsfält på ön Skye, Skottland. *Terra*, **67**, 45–8.
- Evans, D.J.A. (1989) The nature of glaciotectonic structures and sediments at sub-polar glacier margins, north-west Ellesmere Island, Canada. *Geografiska Annaler*, **71A**, 113–23.
- Eyles, N. (1979) Facies of supraglacial sedimentation on Icelandic and Alpine temperate glaciers. *Canadian Journal of Earth Sciences*, **16**, 1341–1361.
- Eyles, N. (1983) Modern Icelandic glaciers as depositional models for 'hummocky moraine' in the Scottish Highlands. In *Tills and Related Deposits* (eds E.B. Evenson, Ch. Schlüchter and J. Rabassa). Rotterdam, Balkema, 47–59.
- Geikie, A. (1863a) On the glacial drift of Scotland. *Transactions of the Geological Society of Glasgow*, **1**, 1–190.
- Geikie, A. (1901) *The Scenery of Scotland Viewed in Connection with its Physical Geology* 3rd edn. London, Macmillan and Co. 540pp.
- Gray, J.M. and Brooks, C.L. (1972) The Loch Lomond Readvance moraines of Mull and Menteith. *Scottish Journal of Geology*, **8**, 95–103.
- Hodgson, D.M. (1982) Hummocky and fluted moraines in part of NW Scotland. Unpublished PhD thesis, University of Edinburgh.
- Hodgson, D.M. (1986) A study of fluted moraines in the Torridon area, NW Scotland. *Journal of Quaternary Science*, **1**, 109–18.
- Hodgson, D.M. (1987) Coire a' Cheud Chnoic. In *Wester Ross Field Guide* (eds C.K. Ballantyne and D.G. Sutherland). Cambridge, Quaternary Research Association, 127–34.
- Horsfield, B.R. (1983) The deglaciation pattern of the western Grampians of Scotland.

-
- Unpublished PhD thesis, University of East Anglia.
- Peach, B.N., Horne, J., Hinxman, L.W., Crampton, C.B., Anderson, E.M. and Carruthers, R.G. (1913b) The geology of central Ross-shire. (Explanation of Sheet 82). Memoirs of the Geological Survey of Scotland. Edinburgh, HMSO, 114pp.
- Peacock, J.D. (1967) West Highland morainic features aligned in the direction of ice flow. *Scottish Journal of Geology*, **3**, 372–3.
- Robinson, M. (1977) Glacial limits, sea-level changes and vegetational development in part of Wester Ross. Unpublished PhD thesis, University of Edinburgh.
- Robinson, M. (1987a) The Loch Lomond Readvance in Torridon and Applecross. In *Wester Ross Field Guide* (eds C.K. Ballantyne and D.G. Sutherland). Cambridge, Quaternary Research Association, 123–27.
- Sharp, M. (1985) Sedimentation and stratigraphy at Eyjabakkajökull – an Icelandic surging glacier. *Quaternary Research*, **24**, 268–84.
- Sissons, J.B. (1967a) *The Evolution of Scotland's Scenery*. Edinburgh, Oliver and Boyd, 259pp.
- Sissons, J.B. (1976b) *The Geomorphology of the British Isles Scotland*. London, Methuen, 150pp.
- 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., Lowe, J.J., Thompson, K.S.R. and Walker, M.J.C. (1973) Loch Lomond Readvance in the Grampian Highlands of Scotland. *Nature Physical Science*, **244**, 75–7.
- Thompson, K.S.R. (1972) The last glaciers in western Perthshire. Unpublished PhD thesis, University of Edinburgh.
- Wright, W.B. (1937) *The Quaternary Ice Age*. 2nd edn. London, Macmillan and Co., 478pp.