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# Eas Chia-Aig Waterfalls

[NN 176 889]

R.A. Strachan

## Introduction

The Eas Chia-Aig Waterfalls GCR site, near Loch Arkaig, is located within an antiformal inlier of gneissose and schistose Moine semipelites and psammites adjacent to the Great Glen Fault. The inlier lies within the 'Flat Belt' (Clifford, 1957), which elsewhere is dominated by the psammites of the Loch Eil Group. The partially migmatitic gneissose Moine rocks have been correlated on lithological grounds with the Glenfinnan Group succession, which outcrops mainly to the west of the Quoich Line within the 'Steep Belt' (Institute of Geological Sciences, 1975b; Johnstone, 1975; Strachan, 1986; Strachan *et al.*, 1988, 2002a). The site provides an opportunity to examine typical Glenfinnan Group lithologies unaffected by the intense upright F3 folding and associated high tectonic strains characteristic of the 'Steep Belt'. J.E. Wright first mapped the area for the Geological Survey in 1953 and it has been subject to further work by R.A. Strachan (1986).

## Description

The 'striped' gneissose semipelites and psammites are exposed in a rocky, forested gorge at the southern end of Gleann Cia-aig (Figure 8.23). Here the Abhainn Chia-Aig flows over several waterfalls and joins the River Arkaig at its outflow from Loch Arkaig. The site exposes Moine rocks locally termed the 'Achnacarry Striped Formation' (Strachan *et al.*, 1988). The main outcrops by the waterfalls comprise gneissose and schistose psammites and semipelites, which are regularly interlayered on a centimetre-scale (Figure 8.24). Lithological layering is extremely variable in orientation. Thin, white to grey calc-silicate layers are common within the psammites. Subordinate layers of coarsely schistose pelite up to 1–2m thick also occur, with biotite and muscovite defining a prominent fabric, aligned parallel to compositional layering. Concordant and discordant quartz-feldspar segregations are abundant. Amphibolitic mafic sheets and pods, up to 2 m thick, occur within the metasedimentary rocks. A foliation defined by aligned hornblendes is commonly developed adjacent to the margins of the mafic bodies, and lies parallel to schistosity in the adjacent Moine rocks, but their cores are generally massive and locally contain garnet. The mafic bodies are mainly concordant with the gneissose layering but locally they show cross-cutting relationships, suggesting that they represent deformed and metamorphosed dolerite intrusions.

The metasedimentary rocks and amphibolitic bodies are both deformed by close to tight and locally isoclinal folds. At least two separate fold phases can be identified. An early set of tight to isoclinal folds of the bedding and migmatitic segregations probably correspond to structures assigned to the D2 deformation event in this part of the Moine outcrop (Holdsworth and Roberts, 1984; Strachan, 1985). These are refolded by later close to tight folds, which could correspond to either or both of the D3 and D4 deformation events identified a few kilometres to the southwest (Strachan, 1985). The later folds generally trend north–south and show gently to steeply plunging axes, but they vary in style from recumbent to upright and are markedly dis-harmonic with varied axial surface orientations. The Moine rocks are intruded by numerous discordant granitic veinlets and pegmatite veins, some of which lie parallel to the axial surfaces of the D3/D4 folds. Some of the granitic veinlets have marginal biotite selvages and have probably formed *in situ* by segregation or even local partial melting.

The grade of metamorphism is difficult to evaluate because of the lack of aluminosilicate minerals. The presence of hornblende and garnet in the amphibolites and calc-silicates indicates amphibolite-facies conditions. The ubiquitous migmatitic segregations suggest that at least middle-amphibolite conditions prevailed both prior to D2 and during D3/D4. This is consistent with the presence of sillimanite elsewhere in the Achnacarry Striped Formation (Institute of Geological Sciences, 1975c). The markedly disharmonic D3/D4 fold styles are characteristic of high metamorphic grade rocks, which contain segregation veins and possibly indicate localized partial-melting at the time of deformation (e.g. Hopgood, 1980;

McLellan, 1984).

Downstream of the waterfall, the Moine rocks are cut by a discordant 1 m-thick, NW-trending microdiorite sheet. Although largely undeformed, the original igneous mineralogy has been modified by lower amphibolite-facies metamorphism. The intrusion is probably a member of the late Caledonian Microdiorite Sub-suite (Smith 1979), which was emplaced in mid-Silurian times during the final stages of the orogeny. Upstream of the waterfall, the gneisses are cut by a 1 m-thick, E–W-trending, fine-grained basaltic dyke. It shows no signs of deformation or metamorphism and is probably a camptonite of the Permo–Carboniferous alkali-basalt dyke-swarm.

## Interpretation

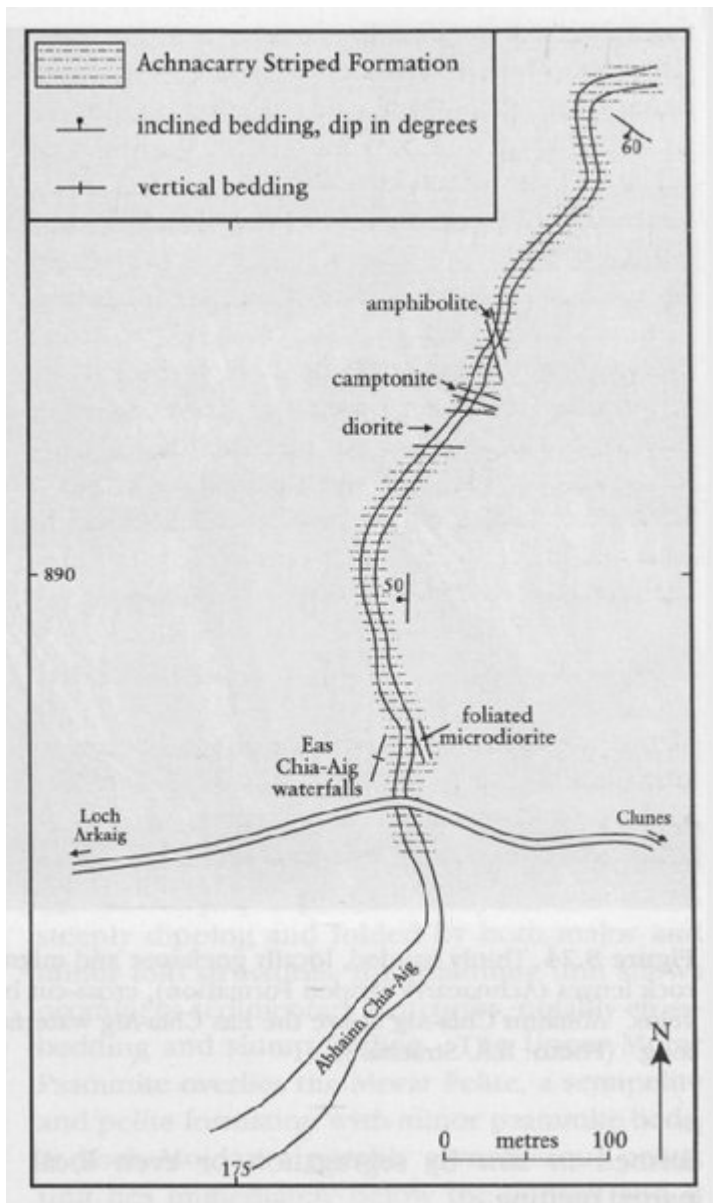
The significance of the Eas Chia-Aig Waterfalls GCR site lies in the occurrence of Moine migmatitic gneisses within largely non-migmatitic psammites of the Loch Eil Group that underlie the majority of ground between the Quoich Line and the Great Glen Fault. Johnstone (1975) suggested on lithological grounds that these gneisses correlate with the Glenfinnan Group rocks, which underlie the Loch Eil Group c. 12 km to the west. Subsequent work near the site has shown that the Achnacarry Striped Formation passes transitionally into the structurally overlying and younger rocks of the Loch Eil Group, supporting the suggested correlation (Strachan, 1986). The rocks lie in the core of a broadly antiformal zone of folds and are therefore plausibly interpreted as a fold inlier of the Glenfinnan Group (Strachan *et al.*, 1988). Similar relationships are seen to the north-east where the Achnaconeran Striped Formation also passes laterally and vertically up into Loch Eil Group psammites (May and Highton, 1997). Both the Glenfinnan Group and Loch Eil Group rocks share a common tectonothermal evolution and the absence of significant migmatization within the Loch Eil Group is attributed to its relatively quartz-rich psammitic nature (see also Fassfern to Lochailort Road Cuttings GCR site report, this chapter).

By analogy with Glenfinnan Group rocks in their type area, the early gneissic layering and migmatitic segregations within the Achnacarry Striped Formation probably formed during the Neoproterozoic tectonothermal event known to have affected the Glenfinnan Group at c. 870 Ma (Friend *et al.*, 1997). The age of the D2 folding is uncertain. The D3/D4 folds are thought to be of the same age as the Caledonian upright folds, which dominate the structure of the 'Steep Belt', i.e. Ordovician or Silurian in age (see Roberts and Harris, 1983; Roberts *et al.*, 1984; Strachan *et al.*, 2002a). The disharmonic D3/D4 fold styles, variable foliation attitude and discordant contacts within the gneisses at the site contrast with the highly flattened, more-harmonic fold styles, uniformly steep foliation attitude, and concordant contacts characteristic of the Glenfinnan Group within the 'Steep Belt'. These differences are attributed to variations in the intensity of Caledonian tectonic strain across the North-west Highlands during this D3 phase of folding.

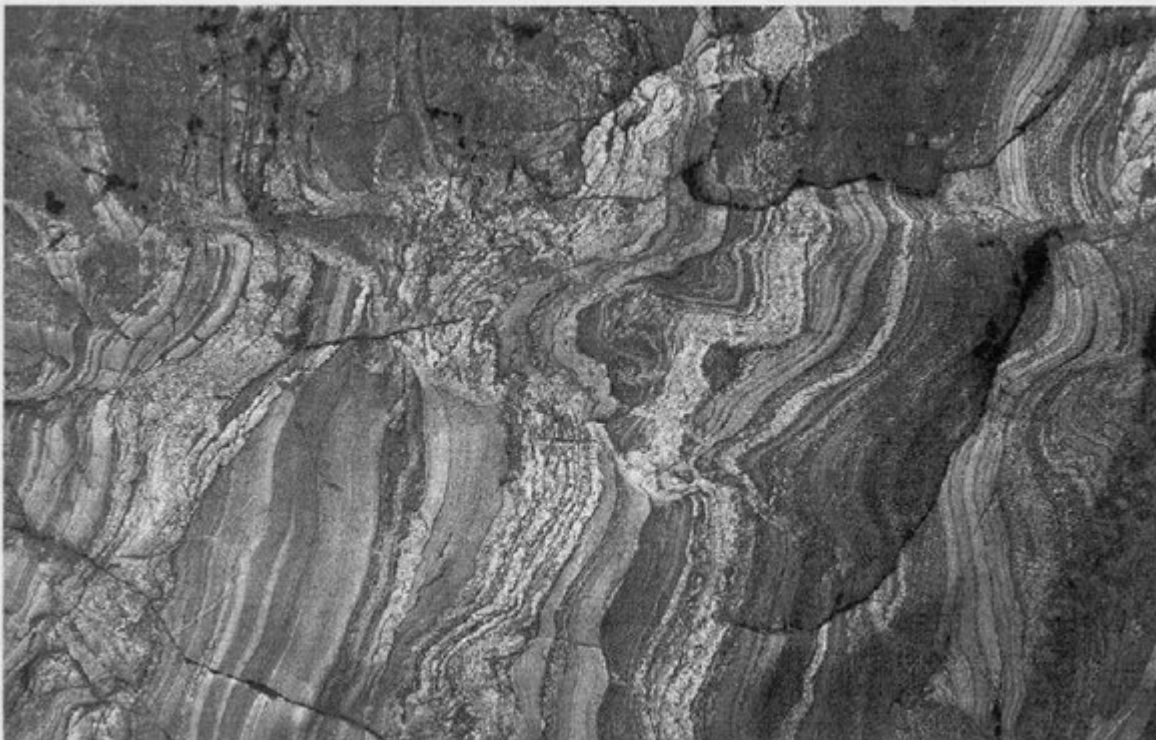
## Conclusions

The Eas Chia-Aig Waterfalls site is located within the 'Flat Belt' and exposes gneissose Moine psammites and semipelites of the Achnacarry Striped Formation. The gneissose rocks display evidence for polyphase folding and migmatization; fold styles are markedly disharmonic and the foliation attitude highly variable. The gneisses form part of an antiformal inlier of the Glenfinnan Group, which is surrounded by the structurally overlying and younger psammites of the Loch Eil Group. The main outcrop of the Glenfinnan Group is located farther west within the 'Steep Belt', and the site is important as it provides a unique opportunity to examine Glenfinnan Group lithologies where they are unaffected by the high tectonic strains and tight folding characteristic of the Caledonian D3 steep belt.

## [References](#)



(Figure 8.23) Map of Eas Chia-Aig Waterfalls GCR site.



*(Figure 8.24) Thinly banded, locally gneissose and migmatitic psammite, semipelite and pelite with calc-silicate rock lenses (Achnacarry Striped Formation), cross-cut by concordant and discordant quartz-feldspar pegmatite veins. Abhainn Chia-Aig above the Eas Chia-Aig waterfalls [NN 176 890]. The compass (upper right) is 10 cm long. (Photo: R.A. Strachan.)*