
Allt Cracaig Coast

[NG 799 176]–[NG 788 169]

A.J. Barber

Introduction

The Allt Cracaig Coast GCR site and its hinterland provide a clear example of an inverted Moine cover–Lewisianoid basement unconformity. Inverted Moine rocks lie structurally beneath Lewisianoid gneisses at the western margin of the Glenelg–Attadale Inlier, and sedimentary structures show that the E-dipping Moine psammites 'young' westwards and downwards, away from the overlying Lewisianoid gneisses. A deformed meta-conglomerate has locally been identified in the basal Moine units. Gneissic layering in the Lewisianoid rocks, which is normally parallel to transposed bedding in the adjacent Moine, here shows a recognizable angular discordance. It is clear that the Moine sediments were originally deposited unconformably on a crystalline Lewisianoid basement that had already undergone intensive deformation and metamorphism. The section is historically important, as it was here that the Lewisianoid and Moine rocks of the Northern Highlands were shown to be distinct structural and stratigraphical units, which had been deformed and metamorphosed together during the Caledonian Orogeny and possibly earlier during a Knoydartian orogenic event.

The area around Glenelg was originally mapped by C.T. Clough as part of the primary survey of the Glenelg (Sheet 71) (Geological Survey of Scotland, 1909), and the geology is described in the accompanying memoir (Peach *et al.*, 1910). Bailey and Tilley (1952) briefly visited the Allt Cracaig section and confirmed the occurrence of conglomeratic rocks along the Moine–Lewisianoid boundary. Following detailed structural mapping, Ramsay (1957b) produced a revised geological map and published a full account of the geology, with details of the structure and of the relationships between the Moine and Lewisianoid rocks. The work of Clough and Ramsay has been drawn upon extensively in the present account. The Allt Cracaig coastal section is complementary to the Attadale and the Eilean Chlamad–Camas nan Ceann GCR sites.

Description

The Allt Cracaig coastal section extends for 2.5 km along the Sound of Sleat between Port a' Gharaidh and Rubha a' Chamais Bhàin (Figure 7.22). It consists of a discontinuous shore platform, backed in places by low cliffs. The hill-slope above the shore, as far as the Glenelg–Arnisdale road, is forested and outcrops on this slope are currently inaccessible. To the southeast of the road, heather and bracken-covered hills around Mam nan Uranan (208 m) contain scattered ice-smoothed rock outcrops.

Moine rocks outcrop along the shore, south from Leac nan Tàillearan [NG 793 174] and extend inland up the hill-slope to the south-east, with a maximum outcrop width of 500 m. The bedding and foliation in the Moine psammites dips some 30° towards the south-east. To the south-east, Moine psammites are structurally overlain by a thin unit of Moine petite, followed by metaconglomerate, and finally by Lewisianoid gneisses.

The Lewisianoid gneisses are part of the Western Unit of the Glenelg–Attadale Inlier. They comprise layered hornblende- and biotite-bearing felsic gneisses interbanded with lenticular amphibolite bodies and subsidiary ultramafic pods. A particularly large basic body can be traced south-westwards from Port a' Gharaidh, to the west of Loch nan Uranan (Figure 7.22) as far as the shores of Loch Hourn (Ramsay, 1957b). Adjacent to the contact with the Moine rocks pink quartzofeldspathic gneiss also occurs. This lithology contains randomly orientated hornblende porphyroblasts, up to 2 cm long, which cut across the felsic layering.

A layer of schistose metaconglomerate, less than 10 m thick, underlies the Lewisianoid gneisses and, together with an associated pelite, can be traced south-west from Leac nan Tàillearan [NG 793 174] in discontinuous outcrops along the margin of the Moine outcrop (Figure 7.23). Clough (in Peach *et al.*, 1910) listed the best outcrops of the metaconglomerate at [NG 793 173], [NG 783 161] and [NG 780 156], but currently these outcrops lie within the forested

area. Clough noted that the metaconglomerate contains pebbles of quartz, red feldspar and yellow-green epidote, in a dark-grey foliated micaceous matrix. The pebbles are flattened in the foliation and are commonly elongated, parallel to the lineation in the Lewisianoid gneisses. The grain size ranges from millimetre-sized grains, to boulders up to 1 m or so. Pebbles larger than 1–2cm show an internal foliation, commonly discordant to the foliation in the matrix. These pebbles have clearly been derived from the nearby Lewisianoid gneisses, but the clasts show less-intense deformation and recrystallization than the adjacent gneisses. The pebbles in the metaconglomerate are generally matrix-supported, but at [NG 787 165] clast-supported boulders of hornblende schist, up to 1 m long, occur.

The matrix of the metaconglomerate contains large flakes of biotite typically orientated sub-parallel to the overall foliation, but in places discordant and crenulated. Epidote grains are common, and at [NG 787 165] abundant small red garnets and black hornblende crystals are prominent, the latter as needles or stout prisms, which locally cross-cut the foliation. The hornblende crystals resemble those in the adjacent Lewisianoid gneisses and also occur in the pelite beneath the metaconglomerate, but are absent from outcrops north of [NG 787 165]. The pebbles in the metaconglomerate become smaller and less abundant structurally downwards into the underlying pelite (Clough in Peach *et al.*, 1910).

The Moine pelite is schistose with biotite and muscovite defining the schistosity, but thin interbeds of quartzose psammite are common. Pink pea-size garnets occur in both pelitic and psammitic layers, and needles and flakes of actinolitic amphibole are abundant in some layers. Microcline occurs locally in the micaceous layers (Peach *et al.*, 1910, p. 51). Cross-cutting hornblende and microcline appear to be restricted to this westernmost Moine outcrop; neither mineral has been reported from Moine pelite outcrops within the inlier farther to the east.

Moine psammite underlies the pelite, and is well exposed along the coastal section. The psammite is a grey, uniform, fine-grained, quartzofeldspathic-rich rock, in which original clasts of red feldspar and grey opalescent quartz may still be recognized (Clough in Peach *et al.*, 1910, p. 53). The psammite is banded with centimetre-thick, pale-grey, quartz-feldspar layers, alternating with millimetre-thick, dark-grey, biotitic micaceous layers reflecting original compositional variations. Some darker layers contain abundant magnetite and ilmenite, and other heavy-mineral grains, suggesting that the psammites form part of the Arnisdale Psammite, the lowest psammite unit in the Morar Group of this area (Ramsay and Spring, 1962; Holdsworth *et al.*, 1994). Cross-bedding is common, and shows that the beds are inverted and young to the west. Irregularly folded laminae, confined between uniformly planar layers, are interpreted as slump folds or convolute bedding (cf. Peach *et al.*, 1910, fig. 6).

The western outcrops of the Moine psammites contain few pegmatitic veins or lenses or migmatitic segregations, unlike Moine pelites and psammites farther to the east. The beds and some thin concordant quartz veins are locally deformed into long-limbed tight folds.

Clough (in Peach *et al.*, 1910, p. 21) described discordances between lithologies and layering in the Lewisianoid gneisses and the underlying Moine succession in the Allt Cracaig area. At the south-west end of the section, hornblende schist lies adjacent to Moine contact, but to the northeast pink quartzofeldspathic gneiss intervenes and thickens to 10–15 m; farther north-east a second body of hornblende schist lies adjacent to the contact. Locally, an angular difference of up to 12° between the strike of the layering in Moine and Lewisianoid rocks is mapped (e.g. at [NG 783 161]). Ramsay (1957b) confirmed these observations, but this locality is now forested.

Interpretation

The interlayered Moine and Lewisianoid rocks in the Glenelg–Attadale Inlier normally show similar structural and metamorphic features, and in most areas the foliation and compositional banding of both groups of rocks appear to be conformable. However, in the Allt Cracaig coastal section on the western side of the inlier, the Moine rocks show evidence of only moderate deformation and a lower grade of metamorphism (lower-amphibolite facies). The unconformable relationships between Lewisianoid and Moine rocks can also be clearly established. A distinction can be made between those features that are restricted to the Lewisianoid rocks, and therefore record their pre-Moine history, and those features common to both rock units, that are caused by Caledonian (and possibly Knoydartian) deformation. The Lewisianoid gneisses show evidence of a complex tectonic and metamorphic history. Fold patterns are not replicated, and pegmatites and basic bodies are absent from the adjacent Moine rocks. It is clear that prior to deposition

of the Moine succession the Lewisianoid rocks have been folded, metamorphosed under middle amphibolite-facies conditions, and intruded by mafic bodies and by pegmatites.

Based largely from his observations in the Allt Cracaig area, Clough (in Peach *et al.*, 1910) marshalled the arguments for an original unconformable relationship between the Lewisianoid and Moine rocks. A convincing element was the occurrence of a basal metaconglomerate containing recognizable Lewisianoid clasts immediately adjacent to the Moine-Lewisianoid contact, which itself could be mapped out as discordant (see above). In addition, there are marked contrasts between the structural and metamorphic features of the two rock units. Clough (in Peach *et al.*, 1910) also reported that in continuously exposed vertical sections (e.g. at [NG 786 164]) no thrust plane or other structural discontinuity could be detected between the Lewisianoid gneisses and the underlying Moine succession. He concluded that the contact is a plane of unconformity, modified by later deformation.

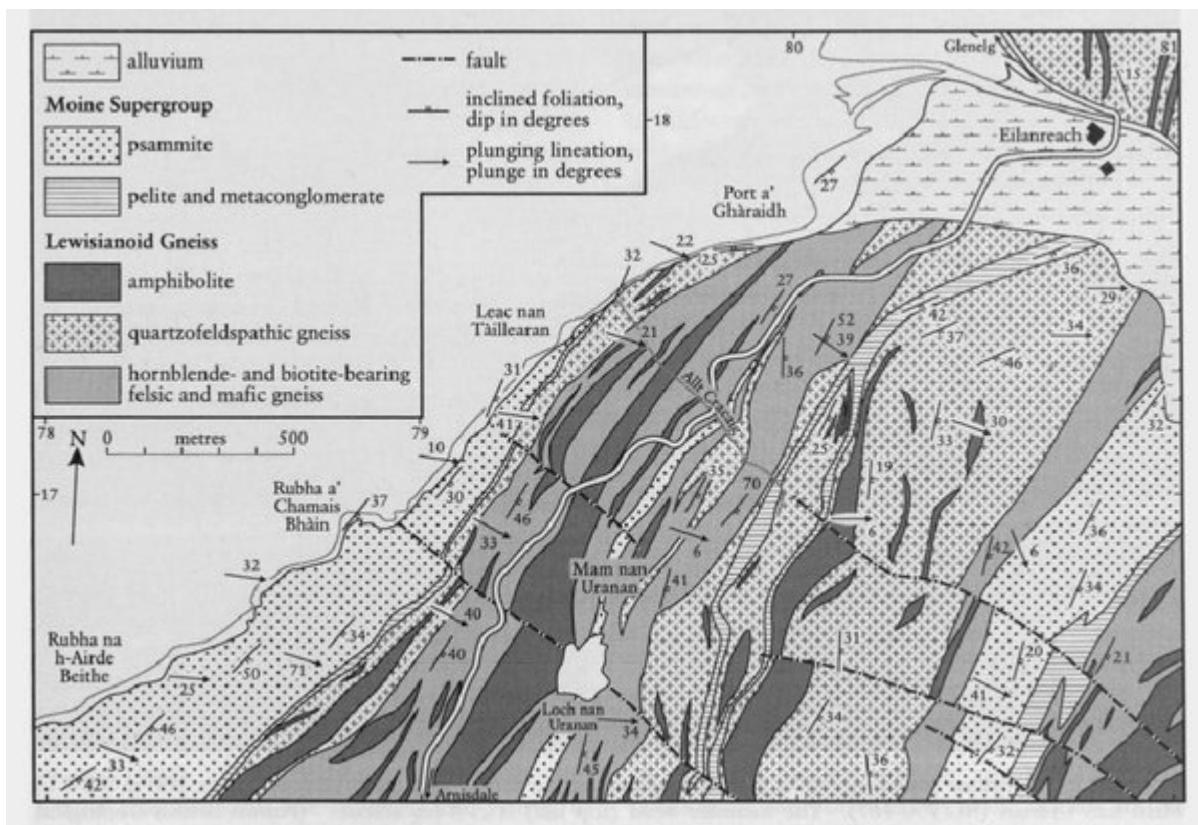
After deposition of the Moine sediments, both rock groups have been intensely affected by the Caledonian Orogeny and possibly by the earlier Knoydartian events. The Lewisianoid basement and its Moine cover were folded and interleaved to produce the present alternating outcrop pattern seen in the inlier (see also Rubha Camas na Cailinn GCR site report, this chapter), in places resulting in an inverted structural succession. In the Moine rocks, metaconglomerate clasts were flattened and elongated, tight to isoclinal folds developed locally, and an ESE-plunging lineation was formed. During the folding, both groups of rocks were intensely deformed, drawing the contacts between rock units into near-parallelism. Original angular Lewisianoid–Moine unconformable relationships were largely destroyed. However, at the Allt Cracaig Coast GCR site the relatively lower strain has resulted in the preservation of a modified unconformity, cross-cutting relationships between mafic dykes and felsic gneisses in the Lewisianoid gneisses, and of sedimentary structures in the Moine psammities (compare with the Rubha Camas na Cailinn GCR site). Metamorphism during the Knoydartian and subsequent Caledonian orogenic events has resulted in pervasive recrystallization of the Moine psammities and pelites and formation of a penetrative schistosity. A later metamorphic event is represented by the prismatic amphibole crystals and large biotite flakes that cross-cut foliation planes; these occur in both the recrystallized Lewisianoid gneisses and the Moine basal metaconglomerate and pelite.

Conclusions

The Allt Cracaig Coast GCR site exhibits critical relationships between the Moine metasedimentary succession and the Lewisianoid basement gneisses of the Glenelg–Attadale Inlier. The Lewisianoid-Moine contact is marked by basal metaconglomerate containing Lewisianoid clasts derived from the adjacent gneisses. Different lithological units within the gneisses are found adjacent to the Moine succession along the contact, and locally an angular discordance between the layering in the Lewisianoid gneisses and the Moine rocks can be recognized, albeit modified by the later deformation. The Lewisianoid gneisses show ample evidence of an extensive earlier history of intrusion, deformation and metamorphism, which pre-dates deposition of the Moine sediments. Hence, the Moine rocks originally constituted a sedimentary sequence of conglomerate, shale and sandstone, resting unconformably on the Lewisianoid basement. During the Caledonian and possibly the earlier Knoydartian orogenies, Moine and Lewisianoid rocks were folded, overturned, and internally deformed and metamorphosed, strongly modifying the unconformity and the adjacent rock units.

Elsewhere in the Northern Highlands, Moine and Lewisianoid rocks are normally so highly deformed and strongly metamorphosed that it is not possible to establish their original relationships. Even in the eastern part of the Glenelg–Attadale Inlier the two units appear conformable. Hence, the Allt Cracaig Coast GCR site is of national importance as it is one of the few places that a convincing Moine-Lewisianoid unconformity can be demonstrated.

[References](#)



(Figure 7.22) Map of the Allt Craicagh Coast GCR site. After Ramsay (195713).



(Figure 7.23) Schistose conglomerate at inverted base of Moine rocks, with clasts of vein quartz, 800 m WSW of Mamnan Uranan [NG 790 167]. The hammer head (top left) is c. 3 cm across.. (Photo: British Geological Survey, No. P214739, reproduced with the permission of the Director, British Geological Survey, © NERC.)