
Attadale

[NG 913 377]

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Introduction

Deformed basal metaconglomerate of the Moine succession is exposed over a distance of 100 m along the A890 road section adjacent to the avalanche shelter south-west of Attadale. The metaconglomerate underlies the Western Unit of the Lewisianoid Glenelg–Attadale Inlier on its western margin and the section represents an inverted unconformity. The discovery of this outcrop contributed to the resolution of the controversy concerning the status of the Lewisianoid inliers in the Moine. The section also clearly demonstrates the different sequence of structural and metamorphic events that have affected the Lewisianoid gneiss basement and its Moine metasedimentary cover during the Caledonian and possibly earlier Knoydartian orogenic events.

The Glenelg–Attadale Inlier is the largest and most westerly of the Lewisianoid basement inliers within the Moine outcrop (Figure 7.2) and the Attadale GCR site lies close to its northern tip. The general dip of the foliation in both Moine and Lewisianoid rocks is gently or moderately eastwards, and hence the Lewisianoid inlier structurally overlies the Moine rocks to the west, which are themselves locally interleaved with further Lewisianoid gneiss sheets. This structural succession rests in turn on the Moine Thrust.

The Attadale area was mapped by L.W. Hinxman in 1902–1903 as part of the primary geological survey of the Lochcarron (Sheet 82) (Geological Survey of Scotland, 1913b) and was described in the Central Ross-shire memoir (Peach *et al.*, 1913). A detailed study by May (1959) focused on the structural and metamorphic evolution of the Lewisianoid and Moine rocks. May (1959) suggested that the 'conglomeratic' rocks were produced tectonically by the disruption of layered gneiss and folded quartz veins during deformation, but new exposures created by the construction of the A890 pointed to a sedimentary origin for the metaconglomerate. A brief description of this locality was published in a field meeting report (Barber and Soper, 1973, p. 227, plate 10). Unfortunately, recent landslips and remedial work have combined to destroy or conceal many of the exposures originally described. The reader is referred to the less-accessible but better exposed localities on the craggy spur above.

Description

Moine rocks forming the western margin of the Glenelg–Attadale Inlier outcrop on hill-slopes along the southern shores of Loch Carron between Attadale and Ardnarff (Figure 7.12). Moine psammites form the core of the complex, NE-plunging Ardnarff Antiform, whose axial plane dips south-east. The fold closes in poorly exposed ground to the south of Ardnarff. On the south-eastern limb, Moine psammites are overlain by semipelites, exposed in the road section south-west of the avalanche shelter, and then by deformed metaconglomerate, which is exposed on both sides of the shelter. Exposures of meta-conglomerate can be traced across the hillside to the south-west of the road section for a distance of 500 m. Lewisianoid gneisses with interlayered amphibolitic mafic and ultramafic bodies, and cross-cutting amphibolite mafic dykes, overlie the metaconglomerate to the north of the shelter and also on the hillsides above the road section. The gneisses are similar to those as described in the Avernish GCR site report (this chapter). The Moine and Lewisianoid sequence is patently inverted.

The A890 road section along the south-east shore of Loch Carron, between Attadale and Ardnarff, is cut into steep and unstable hill-slopes. The railway between Kyle of Lochalsh and Dingwall runs parallel to the road. In the early 1970s an extensive landslip blocked the railway for several months. As a protection from further falls an avalanche shelter was built over both the road and railway. The road section on either side of the avalanche shelter provides intermittent exposure of the metaconglomerate in cliffs up to 30 m high. Further exposures occur in rocky knolls on the hill-slopes of Aonach Baile na Creige.

In the road section, exposures commence 200 m south-west of Cuddles Point [NG 917 384], where a 15 m-high cliff on the south-eastern side of the road, covered by wire netting, exposes near-horizontally layered and foliated Lewisianoid hornblende and biotitic felsic gneisses. The gneisses contain bodies of pink quartzofeldspathic gneiss, with biotite-rich schlieren flattened in the foliation, and a 10 m x 4 m lens of amphibolite.

Just to the north-east of the avalanche shelter, the gneisses are underlain by a massive dark-brown rock containing pale-pink elongated streaks. This is the basal Moine metaconglomerate, and the pink streaks are deformed quartzofeldspathic pebbles. The 30 m-high cliff to the south-west of the avalanche shelter is composed entirely of meta-conglomerate (Figure 7.13). Locally, pebbles are up to 5 cm long and 2 cm wide and are closely packed. The pebbles include quartzofeldspathic gneiss, pegmatite and vein quartz. Elongated quartzofeldspathic streaks not readily recognized as pebbles also occur. Differences in pebble shape can be attributed to variations in the competence of the rock types. In exposures on the hillside above the road, pebbles are elongated on foliation surfaces to form rods, up to 8 cm in diameter and 1 m long, which plunge at approximately 20° to the north-east (May, 1959).

Thin sections show that the metaconglomerate matrix is composed largely of mafic minerals including biotite, muscovite, epidote and actinolitic hornblende, with quartz and feldspar. The prismatic hornblende porphyroblasts locally attain 2–5 cm in length, show a random orientation, and may penetrate the pebbles. Similar hornblende porphyroblasts are abundant in the Lewisianoid gneisses adjacent to the metaconglomerate outcrops (Barber and May, 1976). The hornblende porphyroblasts may be broken and bent and enclosed in augen within the matrix schistosity defined by aligned micas, but commonly they are elongate and define the lineation. In thin section they are partially or completely replaced by biotite (May, 1959).

Road cut exposures continue intermittently southward to Ardnarff. Three hundred metres to the south-west of the avalanche shelter, the metaconglomerate is underlain by dark-grey Moine pelite containing psammitic layers up to 1 m thick. The pelite is schistose and composed of biotite with subsidiary muscovite, quartz, plagioclase, epidote and clinozoisite; rare garnet crystals contain epidote inclusions and are enclosed by rims of biotite (May, 1959). Layering in the pelite is folded on a decimetre-scale into NE-plunging recumbent folds.

A kilometre farther to the south-west, near Ardnarff, similarly recumbently folded layered Lewisianoid gneisses are succeeded by Moine psammities. The psammities are composed predominantly of quartz and feldspar, with millimetre- to centimetre-thick micaceous layers and rare magnetite and epidote-rich layers up to 2 cm thick. Small garnet crystals occur rarely (May, 1959).

The rodding lineations in both the Lewisianoid and Moine rocks of the site area plunge to the north-east, parallel to the recumbent fold axes. In places, a fine ESE-plunging mineral lineation is superimposed on the rodding. Exposures along the road section show that Lewisianoid gneisses and interlayered Moine pelites and psammities are folded into reclined folds with NE-plunging axes. This accords with the fold sequence established elsewhere in the Glenelg–Attadale Inlier, for instance at the Beinn a' Chapuill GCR site.

Interpretation

At the Attadale GCR site, typical Lewisianoid gneisses of the Western Unit of the Glenelg–Attadale Inlier are structurally underlain by metaconglomerate containing clasts of quartzofeldspathic gneiss and quartz-feldspar pegmatite. The felsic gneiss clasts and the dominantly mafic matrix to the metaconglomerate are probably derived mainly from the Lewisianoid basement. The contact between the Lewisianoid gneisses and the Moine succession evidently represents an inverted unconformity. The metaconglomerate is structurally underlain by a basal semipelite unit, followed by psammities, a sequence compatible with the basal Moine succession elsewhere in the North-west Highlands ((Figure 7.3); Ramsay and Spring, 1962; see also Allt Craicig Coast GCR site report, this chapter). Note that c. 800 m ESE of the avalanche shelter metaconglomerate is tightly infolded with Lewisianoid gneisses on the eastern side of the Glenelg–Attadale Inlier (Figure 7.12)a. The units dip moderately south-east and the Basal Semipelite Formation is present along much of this margin, showing that the sequence here is regionally right-way-up and hence the Moine-Lewisianoid unconformity is repeated by large-scale tight recumbent folding.

In the road section between Attadale and Ardnarff, Moine metasedimentary rocks are interleaved with Lewisianoid gneisses and both units are folded into large-scale sideways-closing recumbent folds with NE-plunging axes. The Ardnarff Antiform is interpreted as a composite structure involving two earlier phases of folding. The first fold phase (D1) resulted in the inter-layering of the Lewisianoid and Moine units (e.g. Rubha Camas na Cailinn GCR site). Small-scale representatives of these long-limbed isoclinal folds are present throughout the Moine outcrops in the area of the inlier. The second fold phase (D2) resulted in recumbent folding of the inter-layered Lewisianoid and Moine rocks and the formation of the associated lineations. This fold phase corresponds with the Beinn a' Chapuill phase of folding in Glenelg (e.g. Beinn a' Chapuill GCR site report, this chapter). The Ardnarff Antiform (Figure 7.12)a is primarily a later open fold, complementary to a synform to the west that passes through Am Meallan (Barber and May, 1976, fig. 2).

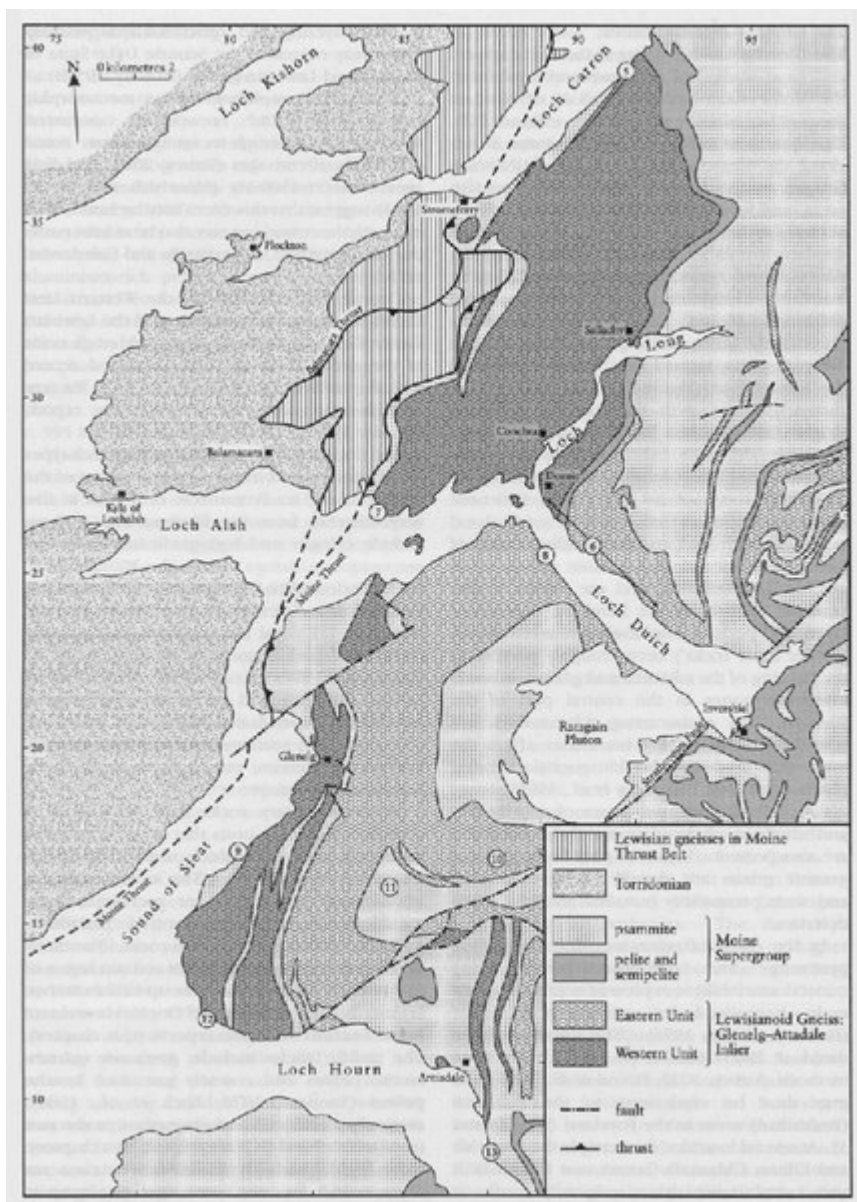
Folding was accompanied and followed by recrystallization of the rocks under amphibolite-facies metamorphic conditions, with the growth of hornblende porphyroblasts, which penetrate pebbles deformed during D2. Later deformation (?D3), represented by fold structures in the Moine, resulted in the formation of a new foliation which disrupted the hornblende porphyroblasts. Biotite, partially or completely replacing hornblende, recrystallized in the new foliation.

Conclusions

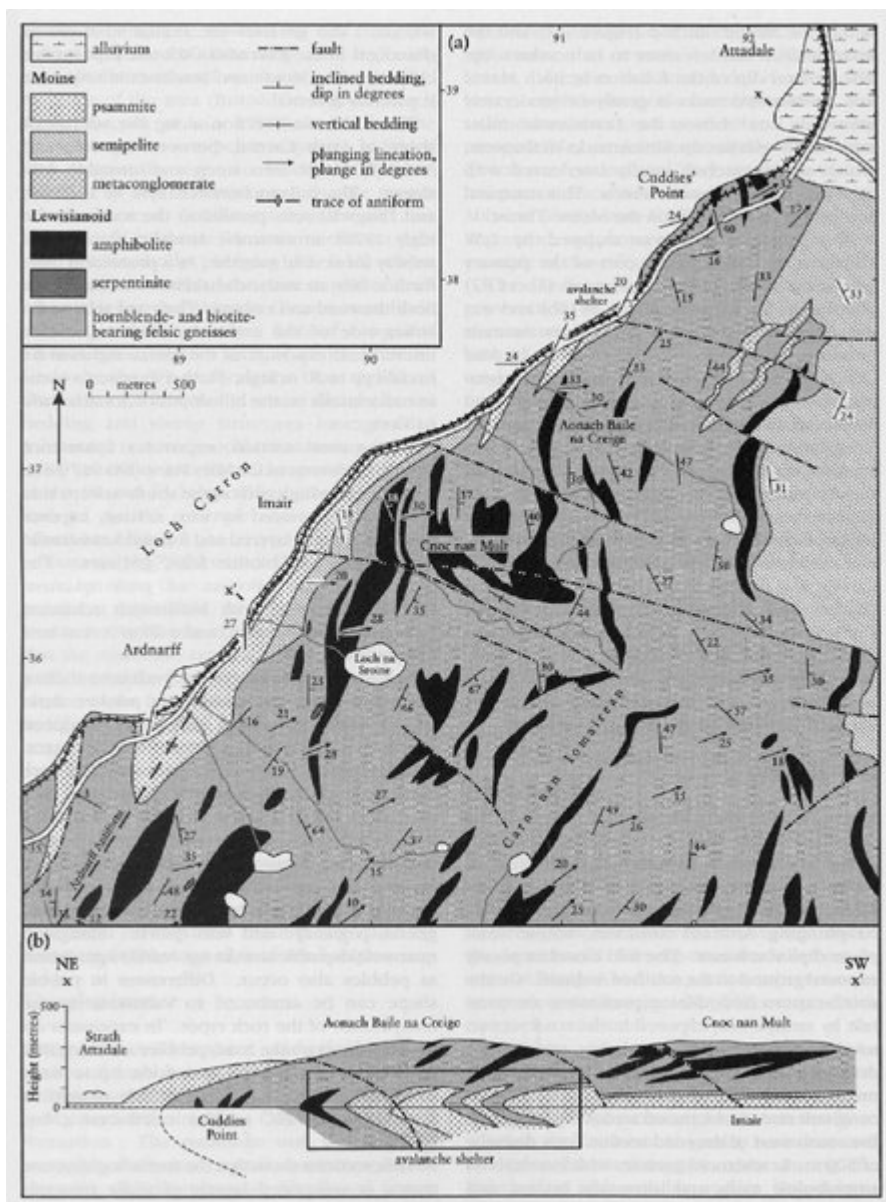
The Attadale road section provides the clearest and most complete cross-section across the western margin of the Glenelg–Attadale Inlier. It provides the most convincing outcrop of a local basal metaconglomerate to the Moine succession, structurally overlain by Lewisianoid gneisses resulting in an inverted unconformity. The site is of national importance in that it demonstrates unequivocally that the Lewisianoid gneisses represent the crystalline basement to the Moine and are not an intrinsic part of the Moine sequence, as once thought. Despite intense deformation that has brought the layering in the Lewisianoid basement into parallelism with the contact with its overlying Moine metasedimentary cover, original unconformable relationships can be inferred from the presence of derived Lewisianoid clasts in the metaconglomerate.

The section also demonstrates that Lewisianoid basement and Moine cover rocks were both affected by the same sequence of structural and metamorphic events during the Caledonian Orogeny and possibly during Knoydartian deformation and metamorphism. Early inter-layering of Moine and Lewisianoid rocks was followed by tight folding and recrystallization of both rock units in the amphibolite facies.

[References](#)



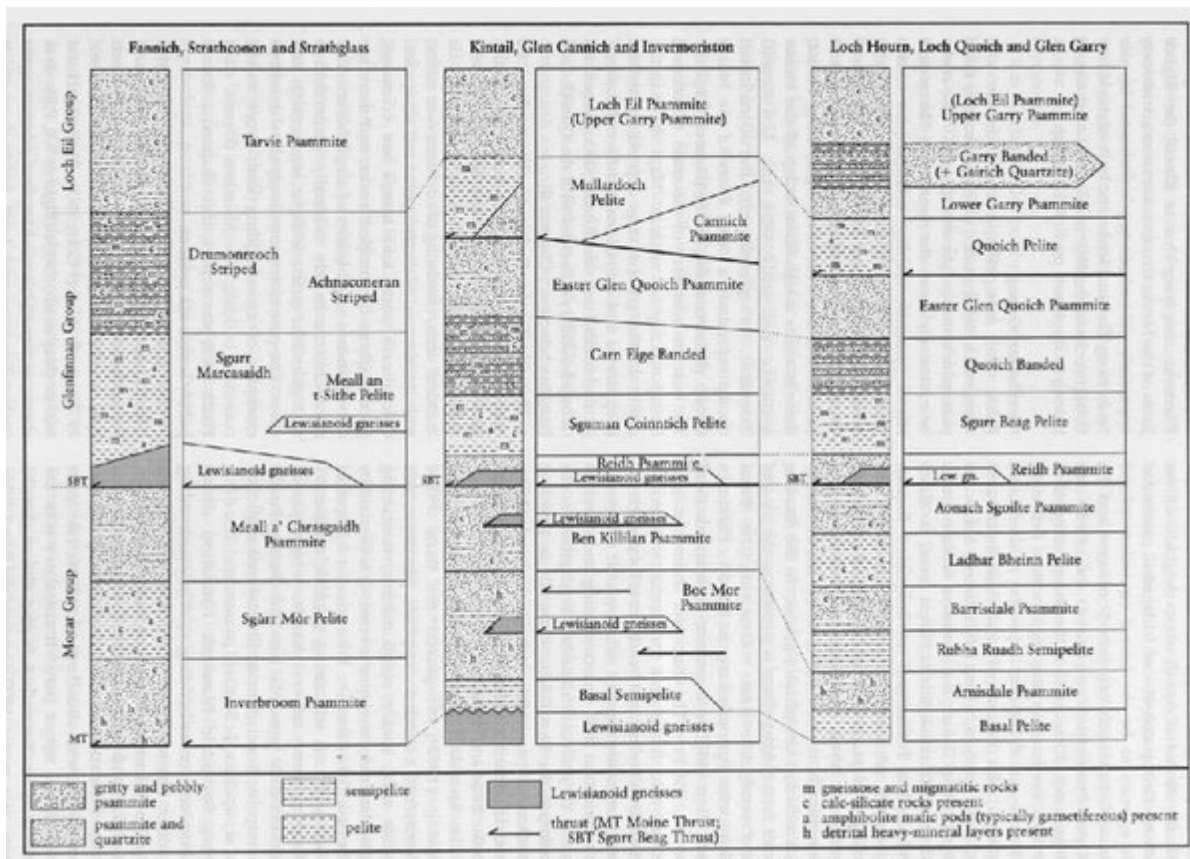
(Figure 7.2) Geological sketch map of the Glenelg-Attadale Inlier and surrounding area (after Barber and May, 1976), showing the location of the GCR sites within or marginal to the Glenelg-Attadale Inlier. 5 — Attadale; 6 — Dornie—Inverinate Road Section; 7 — Avernish; 8 — Totaig; 9 — Allt Craaig Coast; 10 — Druim Iosal; 11 — Beinn a' Chapuill; 12 — Eilean Chlamail—Camas nan Ceann; 13 — Rubha Camas na Cailinn.



(Figure 7.12) Geological map (a) and cross-section (x—x') (b) of the Attadale GCR site and surroundings Based on field mapping by F. May, and Barber and May (1976).



(Figure 7.13) Flattened quartzofeldspathic clasts in schistose matrix, basal Moine conglomerate, above avalanche shelter, Attadale. The hammer is 37 cm long. (Photo: A.J. Barber.)



(Figure 7.3) Tectonostratigraphy of the Moine succession within the Moine (Central) area.