
Rubha Camas na Cailinn

[NG 850 089]–[NG 852 079]

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Introduction

At the peninsula Rubha Camas na Cailinn on the northern shore of Loch Hourn, complex and tightly interfolded Moine and Lewisianoid rocks are exposed on a wave-washed rock platform. The rocks occur south-east of the Strathconon Fault at the southernmost extremity of the Glenelg–Attadale Inlier (Figure 7.2). In this area Lewisianoid gneisses form strips less than 1 km in width, much narrower than farther north, and Rubha Camas na Cailinn is situated at the southern tip of one such strip. Early 'F1' folds refolded by F2 folds were instrumental in the interfolding of Moine and Lewisianoid rocks. The Moine rocks surrounding the gneisses comprise psammite, pelite and semipelite, the basal units of the Morar Group (Ramsay and Spring, 1962; Holdsworth *et al.*, 1994). The gneisses at the GCR site are assigned to the Western Unit of the Glenelg–Attadale Inlier, but narrow strips of the Eastern Unit occur about 1 km to the north-east (Figure 7.2).

The Arnisdale area was mapped by C.T. Clough as part of the primary geological survey of the Glenelg (Sheet 71) (Geological Survey of Scotland, 1909). J.G. Ramsay remapped the area in the late 1950s, paying particular attention to the structure, the relationships between the Lewisianoid and Moine rocks, and the Moine stratigraphy (see Ramsay and Spring, 1962). Most of the following description and (Figure 7.30) are derived from Ramsay's detailed work.

Description

At the seaward fringe of Rubha Camas na Cailinn on Loch Hourn, 2.5 km SSE of Arnisdale, is an ice-smoothed and wave-washed rock platform that provides a total section some 180 m long and 10–15 m wide. On the headland, Moine psammites are interlayered with three distinct strips of Lewisianoid gneisses (Figure 7.30), whereas farther east only psammites are present. The psammites constitute the lower part of the Arnisdale Psammite Formation (Morar Group) and are pale- to dark-grey with prominent internal layering defined by feldspathic psammite alternating with thin mica-rich semipelite, representing original silty layers in the sandstone succession. The psammite is partly garnetiferous and a prominent schistosity is developed in the more-micaceous layers. The psammites also contain pale yellow-green layers rich in epidote, and thin dark-grey heavy-mineral bands rich in magnetite and ilmenite (Ramsay and Spring, 1962).

The Lewisianoid gneisses are composed mainly of pink and white quartzofeldspathic layers, with intervening thin black hornblende- and biotite-rich layers on a 2–3 cm scale. These are interlayered with thicker mafic layers of black amphibolite, up to 20 cm in width, and pods of black to dark-green ultramafic hornblendite. A mica and hornblende foliation is developed parallel to the gneissic layering, particularly in the thinner layers. Both Lewisianoid gneisses and semipelitic layers in the Moine contain concordant quartz veins and pegmatitic quartzofeldspathic segregations. Within the gneisses, some quartzofeldspathic lenses are clearly isolated tight to isoclinal fold cores, the relics of folding and boudinage of pegmatite veins.

The overall layering and foliation in both Moine and Lewisianoid units are parallel, and strike roughly north-south with a moderate to steep easterly dip (Figure 7.30). Numerous tight to isoclinal folds occur at the site. Most of these are tight F2 folds, with steeply E-dipping axial planes, E-plunging fold axes and a strong Z-asymmetry. A strong mineral and rodding L2 lineation in both Moine and Lewisianoid rocks plunges 40°–60° eastwards, generally parallel to the F2 fold axes. Locally, isoclinal F1 folds are refolded in the hinges of F2 folds. Outside the F2 fold hinges, the F1 axial planes are parallel to the F2 axial planes and the overall foliation. Where F1 fold axes can be measured, they plunge 30°–40° to the south-east, rather than to the east. Thus, F1 and F2 folds are coplanar, but not coaxial. Locally, the Moine–Lewisianoid contact is folded by F1 tight to isoclinal folds (Figure 7.31). There is no evidence of shearing or basal conglomerate development along the Moine–Lewisianoid contact. The rocks have also been affected by minor post-recrystallization small-scale open folding.

Interpretation

The Rubha Camas na Cailinn GCR site shows the intimate relationships between the Lewisianoid basement gneisses of the Western Unit of the Glenelg–Attadale Inlier and the Moine psammities that formed its original sedimentary cover. Both Lewisianoid and Moine rocks have been strongly deformed and metamorphosed under amphibolite-facies conditions during Knoydartian and Caledonian orogenic events resulting in a complex interference fold geometry that also highlights the competency differences between basement and cover. Although the compositional layering in both Lewisianoid and Moine rocks is parallel, the two rock groups are lithologically readily distinguished. The original unconformable relationship between the two units has been described in the Allt Cracaig Coast GCR site report, this chapter.

The absence of a basal pelitic unit and local metaconglomerate may be an original feature of the Moine depositional basin, with the Moine succession deposited on an irregular surface of Lewisianoid gneisses, or it may reflect early extensional shearing during the Knoydartian event.

In his discussion of Moine–Lewisianoid relationships, Ramsay (1957b) argued that both shearing ('sliding') and folding were instrumental in the tight interleaving of Moine and Lewisianoid rocks in the Glenelg area. Later detailed work from just north of Rubha Camas na Cailinn in the Arnisdale area on the structural relationship between lineations and folding suggested that folding was more important than shearing (Ramsay, 1960). Ramsay and Spring (1962) also showed that in the Arnisdale area a near-continuous outcrop of Moine Basal Pelite Formation follows the Moine–Lewisian contacts on both the east and west sides of the Lewisian 'strips'. Such a symmetrical outcrop pattern is characteristic of folding, rather than shearing. At Rubha Camas na Cailinn it is clear that the disposition of the Moine and Lewisianoid layers results from tight to isoclinal folding, involving both F1 and F2 folds. The site is one of the best places in the Glenelg area to observe F1 folds affecting the Moine–Lewisianoid contact.

The earliest phase of deformation resulted in the formation of anticlines of Lewisianoid basement gneiss and intervening synclines of Moine psammite, resulting in alternating outcrops of the two rock groups. Both units contain long-limbed tight to isoclinal intrafolial minor folds related to this phase of deformation. F1 folds were strongly modified and the layers attenuated by F2 folding, which was accompanied by pervasive recrystallization under amphibolite-facies conditions. The dominant S2 schistosity and the L2 lineation, which is co-linear with the F2 fold axes, were formed at the same time. The structures in Moine and Lewisianoid rocks were brought into conformity, a parallelism reinforced by the cumulative effect of the multiple deformation phases.

Parallelism of mineral lineations and fold axes is commonly explained by wholesale rotation of fold axes towards the finite stretching direction (e.g. Sanderson, 1973; Alsop and Holdsworth, 2002). However at Rubha Camas na Cailinn this mechanism cannot be invoked, as the earlier F1 fold axes do not lie parallel to the mineral lineation, unlike the later F2 fold axes. Some alternative mechanism must have been responsible for the parallelism of F2 fold axes and L2 mineral lineation. The D2 structures are probably Caledonian in age, although the earlier D1 structures are likely to be Knoydartian (Neoproterozoic).

The field relationships at the GCR site, dominated by folding, are incompatible with the suggestion of Temperley and Windley (1997) that many of the structures in Glenelg are the result of Grenvillian (c. 1000 Ma) extension. At Rubha Camas na Cailinn, the Moine and Lewisianoid rocks share the same structures and responded to post-Moine deformation in a similar fashion, indicating that rheological behaviour of the basement gneisses and their metasedimentary cover was little different at the time of deformation.

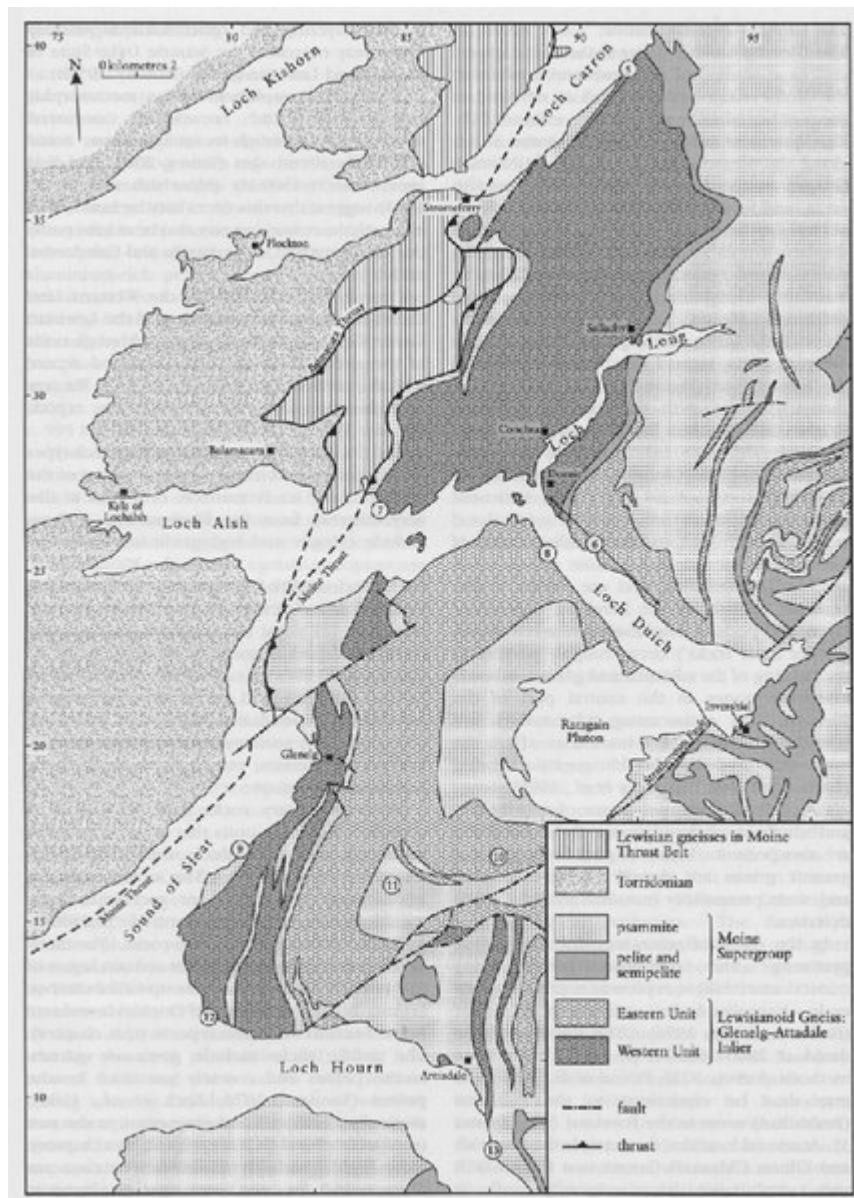
Conclusions

A well-exposed rock platform around the small peninsula of Rubha Camas na Cailinn provides an excellent natural section across interfolded Lewisianoid basement gneisses and their Moine metasedimentary cover. Early F1 folds are refolded by later F2 folds that formed coeval with the peak of metamorphism; this sequence of structures was responsible for the formation of thin 'strips' of Archaean Lewisianoid gneisses within the wider outcrops of early Neoproterozoic Moine psammities. The sequence of structural events can be correlated with that found in many other areas in the Northern

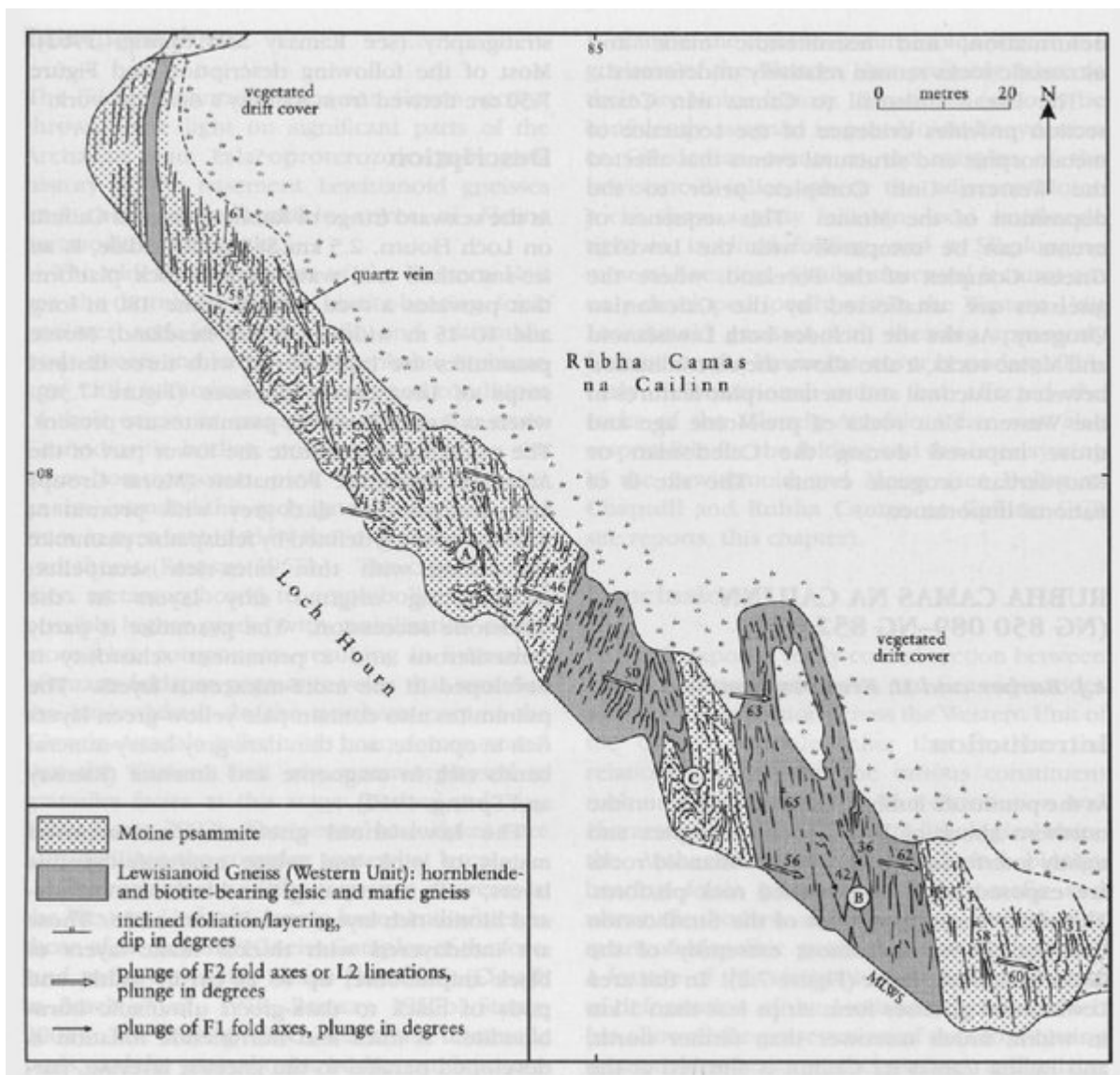
Highlands of Scotland. The structural and metamorphic features in the Moine are the product of Caledonian and earlier Knoydartian tectonic events. The intimate relationships of the Lewisianoid and Moine rocks and their similar structural geometry show that the Lewisianoid gneisses and enclosing Moine psammites shared in these events to the same degree. This implies that the mechanical behaviour of the crystalline basement and the metasedimentary rocks was similar under amphibolite-facies metamorphic conditions.

The site provides a good example of infolding of crystalline basement and sedimentary cover on a very fine scale under high-grade metamorphic conditions. This model is applicable to many other orogenic belts throughout the world and as a result the site is of national and international importance.

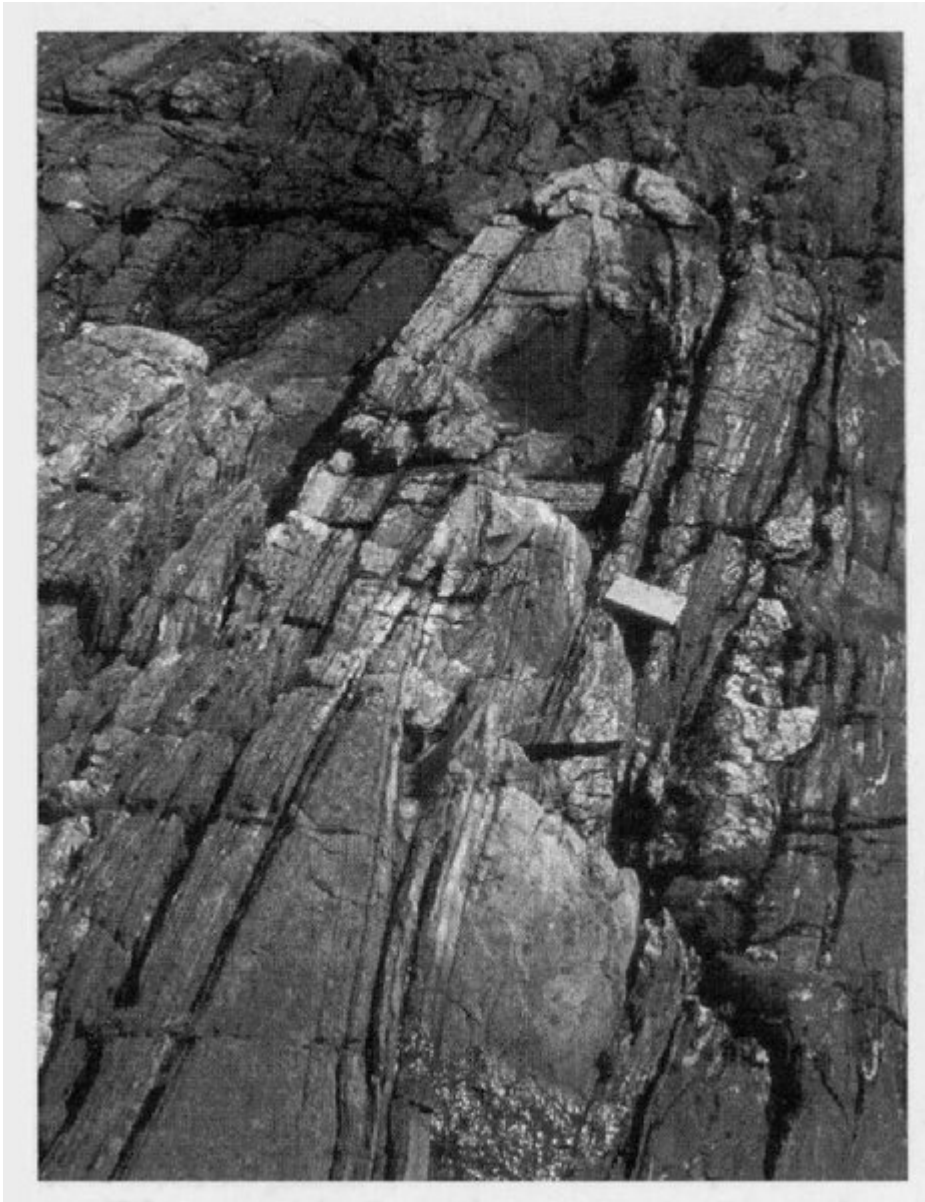
References



(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 Cracaig Coast; 10 — Druim Iosal; 11 — Beinn a' Chapuill; 12 — Eilean Chlamail—Camas nan Ceann; 13 — Rubha Camas na Cailinn.



(Figure 7.30) Detailed map of the Rubha Camas na Cailinn GCR site, from a field map by J.G. Ramsay. F1 folds can be demonstrated at points A, B and C.



(Figure 7.31) Plan view of tight fold closure of Lewisianoid gneiss, cored by Moine psammities. Parasitic folds of probable F1 age are visible left of the notebook. The notebook is 20 cm long. Rubha Camas na Cailinn [NG 8502 0798]. (Photo: M. Krabbendam, BGS No. P571662, reproduced with the permission of the Director, British Geological Survey, © NERC.)