Eilean Chlamail–Camas nan Ceann

[NG 774 129]–[NG 793 117]

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Introduction

The Eilean Chlamail–Camas nan Ceann GCR site covers a 2.6 km-long coastal section on the northern shore of Loch Hourn that provides a cross-section through the basement Lewisianoid gneisses of the Western Unit of the Glenelg–Attadale Inlier and intercalated Moine psammites. As the strain is lower than in other areas of the inlier, the section shows many of the felsic and mafic igneous protoliths that make up the Lewisianoid gneisses, in parts still displaying cross-cutting relationships. It demonstrates the history of the Lewisianoid rocks prior to Moine deposition and the extent to which both the Lewisianoid gneisses and the Moine rocks were modified during the Caledonian and possibly Knoydartian orogenies.

South of the village of Glenelg, the outcrop of the Western Unit broadens to *c.* 4 km wide across the strike (Figure 7.2). It is bounded to the west by inverted Moine rocks that represent the original sedimentary cover to the basement (see Attadale and Allt Cracaig Coast GCR site reports, this chapter), and to the east by the major shear-zone that separates the Western and Eastern units. The rocks of the inlier have generally been strongly deformed such that the major internal lithological units lie near-parallel with the Lewisianoid–Moine boundary (Figure 7.28). Nevertheless, at Eilean Chlamail-Camas nan Ceann zones of lower strain are present and two generations of mafic intrusive rocks can generally be distinguished.

The Glenelg area was mapped by C.T. Clough as part of Glenelg Sheet 71 (Geological Survey of Scotland, 1909) and described in the accompanying memoir (Peach *et al.,* 1910). Much of the following description is drawn from Clough's account. During detailed mapping in the mid-1950s, J.G. Ramsay distinguished the different lithological units within the Western Unit and also made a detailed study of the minor structures and of the Lewisian–Moine relationships (Ramsay, 1957b). Ramsay's detailed field maps at the scale of 1:10 560 form the basis for (Figure 7.28).

Description

The Eilean Chlamail–Camas nan Ceann site provides a clean coastal section along an extensive wave-washed platform between high-and low-tide marks. Exposures also extend into cliffs up to 20 m high behind the shore section. The rock platform is interrupted by small bays and coves with shingle beaches and locally is obscured by large boulders, seaweed and barnacles.

The predominant lithologies of this Western Unit are pale-grey and pink, thinly layered felsic gneisses composed mainly of quartz, plagioclase feldspar, hornblende and biotite. Quartzofeldspathic layers alternate with those rich in hornblende and/or biotite on a millimetre- to decimetre-scale, with occasional pods of amphibolite and ultramafic actinolitic rock (e.g. Peach *et al.,* 1910, plate VIII). The gneisses also contain thin, pale yellow-green, epidote-rich layers and lenses. Homogeneous pink quartzofeldspathic gneisses are also an important rock-type here, forming two main outcrops, one approximately 500 m wide centred on Rubha a' Chaisteil, the other outcropping for approximately 1 km between Glas Eilean and Camas nan Ceann (Figure 7.28).

The gneisses contain sheets, lenses and screens of dark-grey-weathering, black to greenish-black amphibolite. The margins of these amphibolite bodies are commonly parallel to the layering in the surrounding gneiss, but in places cross-cut the layering at a low angle. Plate N of the Glenelg memoir (Peach *et al.,* 1910) illustrates one of these amphibolites from Rubha a' Chaisteil [NG 776 123]. The amphibolites typically contain quartzofeldspathic veins, either as segregations or as intrusions, which in places make up a high proportion of the rock, such that it can be termed 'agmatite'. This rock type is extensively developed in the coastal section to the west of Port an Tairbh [NG 790 117]

(Peach *et al.,* 1910, plate VI). At several localities a second group of dyke-like amphibolite intrusions cut across the earlier felsic gneisses and mafic bodies, discordant to the layering, for example between Rubha a' Chaisteil and Port Luinge [NG 780 122] (Figure 7.28).

Clough (in Peach *et al.,* 1910, p. 41) described one of these cross-cutting dykes, 150 m ENE of Glas Eilean at [NG 7880 1168], as 'a fine-grained band of hornblende schist, one or two feet [3060 cm] thick and foliated nearly parallel to the side, cuts the broad banding of the adjacent gneiss distinctly, the schist running WNW while the gneiss dips east at about 65° (Figure 7.29). The gneiss is to a large extent dark and hornblendic, but coarser in grain than the schist, and mixed with pale-grey more-acid bands quite unlike anything in the schist.'

Ramsay (1957b) distinguished 'older' and 'newer' groups of intrusive amphibolitic rocks. The 'older' group contains a much higher proportion of quartz-feldspar veins, and are commonly recrystallized, whereas the 'newer' group contains very few veins and are not pervasively recrystallized. Although the 'newer' mafic intrusions do not cut the Moine psammites, the development of veining is comparable to that in adjacent Moine psammites (Ramsay, 1957b, p. 495). 'Older' and 'newer' intrusions are readily distinguished where crosscutting relationships are preserved, but this distinction is not possible where the rocks have been highly deformed. The distribution of 'newer' and 'older' mafic intrusions is shown on (Figure 7.28).

A narrow outcrop of Moine rocks occurs in the coastal section between Rubha a' Chaisteil and Port Luinge [NG 779 122]. The Moine rocks are pervasively deformed fine-grained psammites, with alternating quartz-feldspar and mica-rich layers, on a millimetre- to centimetre-scale. They have a strong foliation with a prominent SE-plunging mineral lineation on the foliation surfaces. On their western side, the psammites are in contact with Lewisianoid quartzofeldspathic gneisses, whereas on their eastern side they are in contact with felsic hornblende-biotite gneisses (Figure 7.28). Various Lewisianoid lithologies lie in contact with the Moine along strike. These relationships have been interpreted as demonstrating an unconformable relationship between the Lewisianoid and Moine rocks in the Glenelg–Attadale Inlier (Clough in Peach *et al.,* 1910; Ramsay, 1957b).

The general strike of the layering and the foliation in the gneisses of the Western Unit is north-south in the coast section with dips generally towards the east or ESE at between 40°–60°. However both strike and dip are variable on the scale of the outcrop, with the layering commonly folded. Small-scale tight to isoclinal folds occur in most exposures and early isoclines are locally refolded on similarly orientated axes and axial planes (Ramsay, 1957b, p. 504). The foliation is defined by quartz and feldspar aggregates, hornblende, and micas, normally aligned parallel or near-parallel to the layering, but locally axial planar to tight to isoclinal 'F1' folds. Foliation surfaces contain a subhorizontal N–S- or NNE-plunging quartzofeldspathic rodding lineation, which is folded by later folds at Rubha Buidhe [NG 782 120] and Camas nan Ceann [NG 794 117] (Ramsay, 1957b, p. 509). In highly deformed rocks, a SE-plunging mineral lineation is present, defined by elongated quartz and feldspar crystals and micas (Ramsay, 1962, fig. 8). In places the mineral lineation may be seen superimposed on the rodding lineation.

Excellent examples are seen on the western side of Port Luinge [NG 781 122], where sub-horizontal rodding lineations deformed in culminations and depressions are cut by shear zones, which themselves contain a strong down-dip mineral lineation, plunging towards the south-east.

Although there are strong variations in the degree of deformation on a small scale, in general the strongly layered felsic gneisses are more highly deformed, while more-homogeneous quartzofeldspathic gneisses are less deformed (Ramsay, 1957b). Near Glas Eilean, relatively undeformed coarse-grained felsic gneisses and quartzofeldspathic gneisses may be traced both along- and across-strike into their pervasively deformed equivalents (Ramsay, 1957b). Massive hornblendic and amphibolitic mafic lithologies are least deformed and are commonly preserved as pods in reconstituted quartzofeldspathic gneisses. In the highly deformed felsic gneisses, amphibolite dykes are tightly folded (see Ramsay, 1957b, fig. 2), segmented into boudins, and drawn out into parallelism with the layering in the surrounding gneisses. In the most highly deformed examples, cross-cutting relationships have been effectively obliterated. In the larger dykes, hornblende schist is developed adjacent to the dyke margins, with the schistosity parallel to the margin; equigranular amphibolite is still preserved in the interior. Thinner dykes are completely altered to hornblende schist and the distinction between 'older' and 'newer' basic dykes is no longer possible. Where dykes have been intruded into the less-deformed

homogeneous quartzofeldspathic gneisses, for example between Rubha a' Chaisteil and Port Luinge [NG 778 123] (Figure 7.28), original angular relationships, although modified, are still observed.

Interpretation

The Eilean Chlamail–Camas nan Ceann section throws some light on significant parts of the Archaean and Palaeoproterozoic geological history of the basement Lewisianoid gneisses and their unconformable cover of Moine metasedimentary rocks.

The oldest components of the Western Unit are the hornblende- and biotite-bearing felsic gneisses and included mafic and ultramafic pods, sheets and lenses, all of probable Archaean age. Little is known of the nature and conditions of their origin or emplacement into the crust. Granodioritic bodies, now represented by the more-homogeneous pink quartzofeldspathic gneiss, intruded this early igneous complex, and were in turn intruded by the 'older' mafic dykes and sheets (Ramsay, 1957b). The complex was then metamorphosed to amphibolite facies or possibly higher grade, with mobilization of the more-felsic components resulting in formation of quartz-feldspar pegmatite veins that intruded the basic dykes. In the northern part of the Glenelg–Attadale Inlier it has been demonstrated that the Western Unit was metamorphosed to granulite facies at this stage (Barber and May, 1976; Storey, 2002). The 'newer' basic dykes were intruded into the complex somewhat later.

The rock types and the sequence of events in the Western Unit of Glenelg have similiarities to those of the Lewisian Gneiss Complex of the foreland, to the west of the Moine Thrust Belt (Clough in Peach *et al.,* 1910; Ramsay, 1957b; Storey, 2002). The felsic gneisses, mafic and ultramafic pods, and the granodioritic bodies can be correlated with similar units in the Scourian gneisses of the Foreland. The 'newer' basic dykes are equated with the Scourie dykes which intrude the Scourian/Badcallian rocks of the Foreland. Ramsay (1957b, p. 495) considered the possibility that the metamorphism that converted these mafic dykes to amphibolite and generated the quartz-feldspar pegmatite veins was equivalent to the Laxfordian metamorphic event of the Foreland at *c.* 1750 Ma; recent U-Pb TIMS zircon dating by Storey (2002) has confirmed this hypothesis. Ramsay (1957b) also suggested the metamorphism that affected the 'older' mafic dykes may relate to the Laxfordian event, but the U-Pb zircon data of Storey (2002) suggest that this high-grade metamorphism and agmatite generation occurred some 2600–2800 Ma, equivalent to the Scourian event in the Foreland.

Many of the tight to isoclinal folds seen in the gneisses of the Western Unit probably relate to their pre-Moine history. Structures can only be confidently assigned to post-Moine Knoydartian or Caledonian events at the margins of the Lewisianoid inner, where the adjacent Moine rocks show a platy foliation, local small-scale tight to isoclinal folding, and a SE-plunging mineral lineation. Similar structural features are only developed locally within the Western Unit Lewisianoid gneisses with shearing apparently focused on the basement–cover boundary. This early deformational event that affected the rocks of the Glenelg–Attadale Inlier was also responsible for the folding and the interlayering of the Lewisianoid and Moine (see Beinn a' Chapuill and Rubha Camas na Cailinn GCR site reports, this chapter).

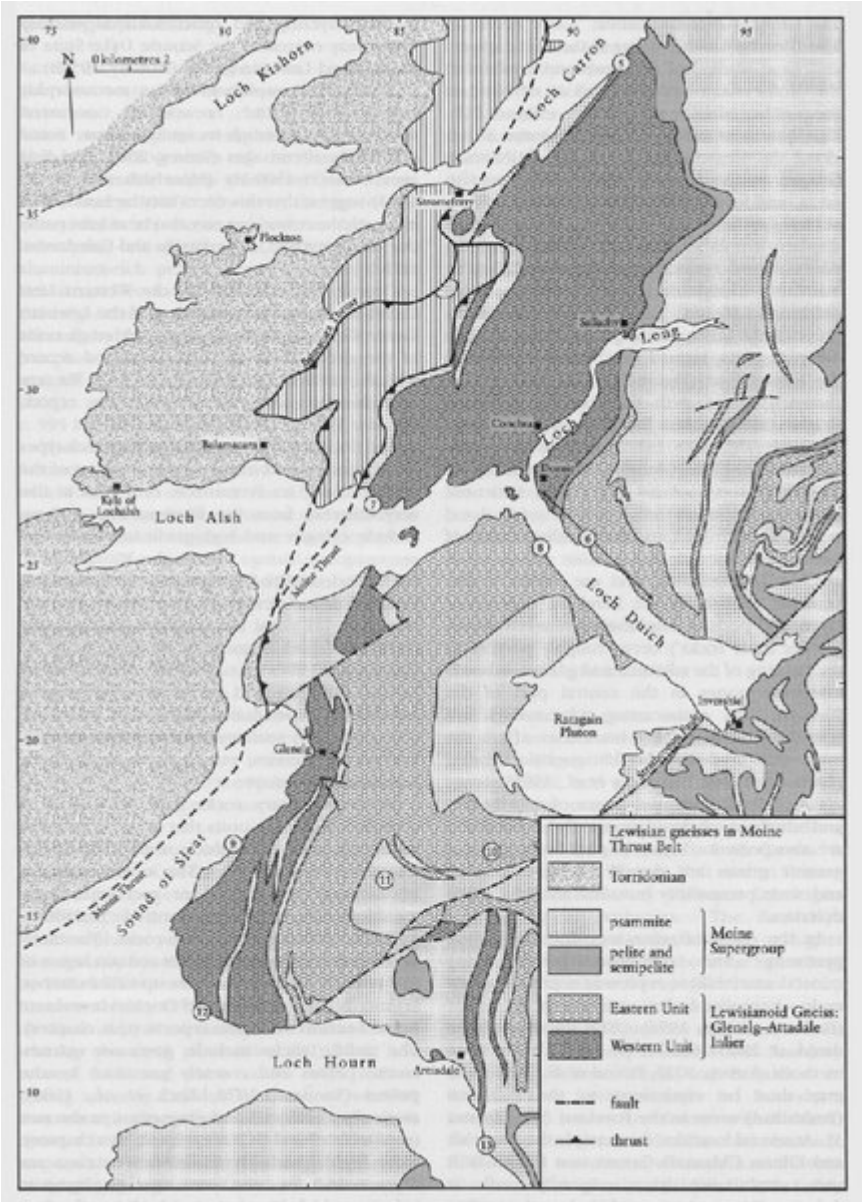
Conclusions

The well-exposed rocky coastal section between Eilean Chlamail and Camas nan Ceann provides a natural cross-section across the Western Unit of the Glenelg–Attadale Inlier that enables the relationships between the various constituent rock units to be studied. The distribution and characteristics of the dominant lithological units, the Archaean-age hornblende- and biotite-bearing felsic gneisses, included mafic and ultramafic bodies, and the pink granodioritic quartzofeldspathic gneisses are well displayed. A feature of this section is the relative low state of deformation of the Lewisianoid rocks, which has allowed the preservation of the cross-cutting relationships between the gneisses and a later swarm of Palaeoproterozoic mafic dykes (Scourie dykes), now represented by amphibolites. Two sets of mafic intrusions can be distinguished; 'older' amphibolite bodies that show penetrative deformation and are intruded by abundant quartz-feldspar veins, and a 'newer' set of mafic dykes that show only local deformation fabrics. In parts cross-cutting relationships between 'newer' and 'older' dykes are preserved.

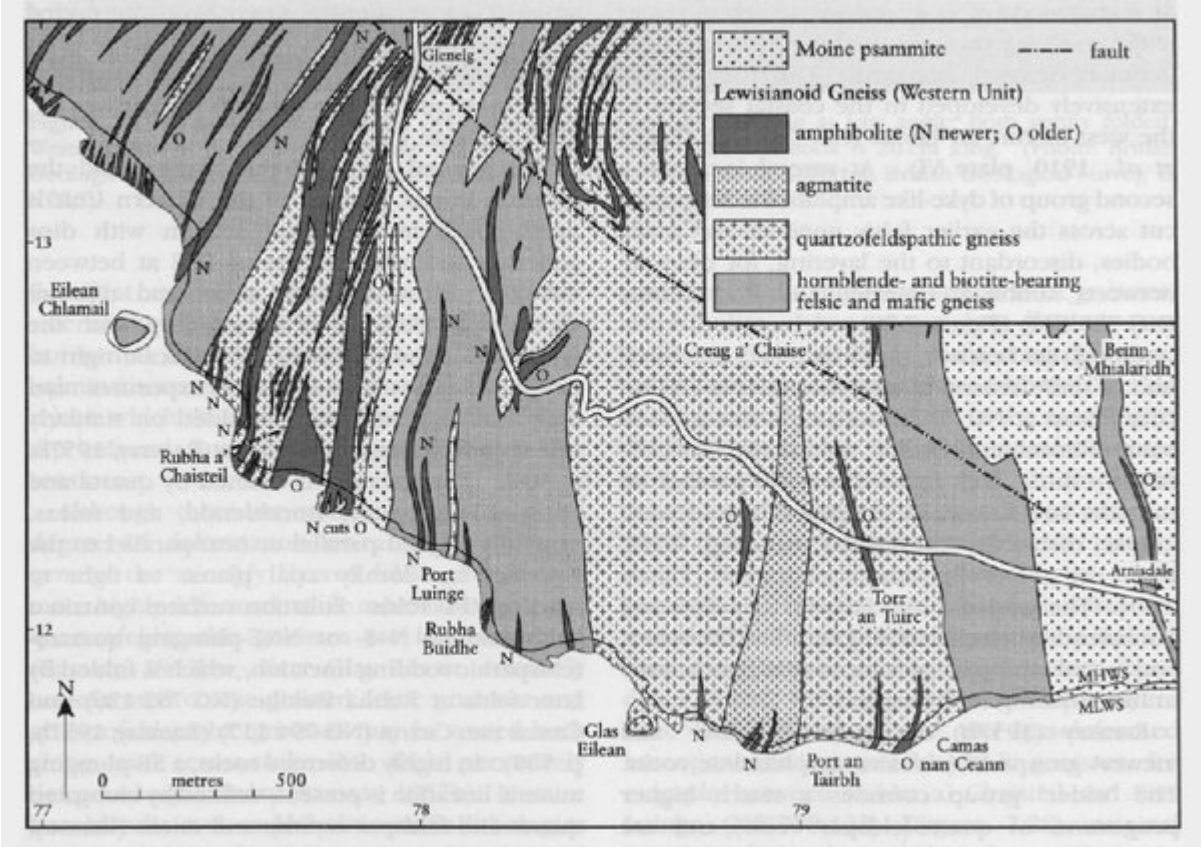
The section clearly demonstrates the important role that lithology plays in controlling the degree of deformation. Deformation preferentially affected the quartz-feldspar-rich units, especially where they are interlayered on a small scale with hornblende- and biotite-rich layers, whereas the homogeneous quartzofeldspathic rocks show less evidence of deformation, and hornblendic mafic and ultramafic rocks remain relatively undeformed.

The Eilean Chlamail to Camas nan Ceann section provides evidence of the sequence of metamorphic and structural events that affected the Western Unit Complex prior to the deposition of the Moine. This sequence of events can be compared with the Lewisian Gneiss Complex of the Foreland, where the gneisses are unaffected by the Caledonian Orogeny. As the site includes both Lewisianoid and Moine rocks, it also allows the discrimination between structural and metamorphic features in the Western Unit rocks of pre-Moine age and those imposed during the Caledonian or Knoydartian orogenic events. The site is of national 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 7.28) Map of the Eilean Chlamail—Camas nan Ceann GCR site. Modified from field maps of J.G. Ramsay.

(Figure 7.29) Amphibolitic 'Scourie dyke' cross-cutting gneissic layering at low angle; both gently folded, Western Unit of the Glenelg—Attadale Inlier [NG 7880 1168]. The notebook is 20 cm long. (Photo: British Geological Survey, No. P571654, reproduced with the permission of the Director, British Geological Survey, © NERC).