
Alligin (Diabaig)

[NG 806 566]–[NG 830 620]

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Introduction

The Alligin GCR site area is one of the two areas where the original division of the Lewisian Gneiss Complex into the earlier Scourian and later Laxfordian components was described by Sutton and Watson (1951). It is therefore one of the most important sites in the Lewisian Gneiss Complex for demonstrating the evidence on which the stratigraphical and chronological framework of the Lewisian has been based. The other area is described in the Tarbet to Rubha Ruadh GCR site report (this chapter). In terms of quality of exposure, it is probably unrivalled; it is possible to walk for several kilometres across virtually uninterrupted rock in which some of the most remarkable petrological and structural features of the complex are clearly displayed. Hence, the Alligin area is one of the most frequently visited Lewisian sites, both by research workers and by student parties for teaching purposes.

The Alligin GCR site lies within the most southerly inlier of the Southern Region, and provides a complete and excellently exposed traverse from the granulite-facies Badcallian enclave of An Ruadh Mheallan in the north to the intensely deformed Laxfordian belt at Diabaig in the south (Figure 3.29). The latter forms the Diabaig Shear Zone at the north-east margin of a wide zone of Laxfordian deformation, extending across Loch Torridon and embracing the whole of the inlier to the south-west of the loch (Figure 3.1).

The area was first mapped and described by L.W. Hinxman (in Peach *et al.*, 1907) for the Geological Survey. A more-complete study was undertaken by Cresswell (1969, 1972), who mapped the elements of the Lewisian gneisses in detail; (Figure 3.29) is based on Cresswell's map. More recently the area has been re-interpreted in terms of more-modern shear-zone theory by Wheeler *et al.* (1987) and Niamatullah and Park (1990), but this work has served to confirm the essential elements of Cresswell's structural mapping and interpretation.

Description

The Alligin GCR site forms a curved elongate area some 5.9 km long and 0.6–1.5 km wide that extends north-east from Loch Shieldaig to the slopes immediately west of An Ruadh Mheallan. The glacially scoured, craggy dissected ground rises rapidly from sea level to c. 300 m and then only rises slowly until at its northern extent it reaches c. 500 m above OD. Lochans, small burns and gullies are common, but the area is dominated by the abundant exposure of the Lewisian gneisses. Torridonian rocks extend down to Loch Diabaigas Airde immediately north-west of the site area, and they also form the prominent hill of An Ruadh Mheallan (671 m) that overlooks the area to the north (Figure 3.29). They are described in the Diabaig GCR site report (Chapter 4).

On the south-west slopes of An Ruadh Mheallan [NG 836 615], lithologies and structures of Scourian gneisses deformed during the Badcallian event are evident, whereas to the north and south these early-formed gneisses are strongly reworked by Inverian and Laxfordian deformational and metamorphic events. The Scourian rocks consist of a series of alternating banded and massive, granodioritic to tonalitic gneisses that represent for the most part an intrusive plutonic complex. The emplacement of the granodiorites and the associated migmatitization has resulted in large areas of homogeneous granitic gneisses and nebulitic migmatites. These rocks enclose a suite of amphibolite bodies ('early basics') that vary in size from small pods to sheets several tens of metres across. These mafic bodies are veined and, in part, agmatitic within the granitic host rock. An ultramafic body, which extends for about 350 m along strike and is up to 40 m in thickness, occurs at [NG 8367 6160] near the northern extremity of the site (Figure 3.29). The body is layered and strongly retrogressed, but relics of a former granulite-facies olivine-hypersthene-spinel assemblage can still be found, interpreted by Cresswell (1969) as due to Badcallian metamorphism. The last Badcallian deformation has resulted in a generally steep N-trending foliation and banding.

The Scourian gneisses and Badcallian structures are cut by a set of NW-trending mafic dykes of the Scourie Dyke Suite (Figure 3.30), typically between 30 m and 75 m in width, of which several large, well-exposed examples form prominent ridges south-west of the summit of An Ruadh Mheallan (Figure 3.29). These dykes are undeformed except for small (millimetre- to centimetre-wide) shear-zones, but have been metamorphosed and are now all amphibolites. Most of the dykes are metadolerites, and exhibit sub-ophitic textures in their undeformed state. However, a few ultramafic dykes are also present, for example 150 m east of Loch na Beiste where an ultramafic dyke cross-cuts a metadolerite dyke. These later dykes are also amphibolitized, but their geochemistry is similar to that of picrites.

Towards the south-west margin of the An Ruadh Mheallan enclave (Figure 3.29) the gneisses become progressively deformed by folds with steeply dipping, NW-trending axial planes. A new related penetrative amphibolite-fades metamorphic planar fabric is also developed. The mafic dykes also become deformed; thicker dykes possess marginal foliated zones whereas thinner dykes are deformed throughout. Careful examination of the relationships between the new foliation in the gneisses and the margins of the dykes shows that some of the NW-trending structures in the gneisses are cut by and thus pre-date the dykes. Cresswell (1972) hence assigned these structures to the Inverian episode, whereas the later NW-trending structures, which do affect the dykes, were assigned to the Laxfordian. This relationship between the dykes and the Inverian and Laxfordian structures is particularly clear south of the road near Loch na Beiste (Figure 3.29). Here the Inverian foliation has an easterly trend and moderate northward dip, and is clearly cross-cut by steep NW-trending dykes.

Cresswell (1972) concluded from his study of the relationships between the Scourie dykes and the earlier structures in the host gneisses that the latter had exerted a significant control over the size, orientation and spacing of the dykes. In areas of strongly developed, steep, NW-trending, Inverian foliation, the dykes are concordant, thinner and more closely spaced than in areas where the pre-existing foliation has a different orientation. This can be demonstrated by comparing the area immediately south of An Ruadh Mheallan, where the pre-dyke foliation has a northerly trend, with the two NW-trending belts lying respectively 1.5 km and 2 km farther to the south-west (Figure 3.29).

The nature of the Laxfordian deformation is strongly reflected by the deformation state of the Scourie dykes, which are numerous in the Alligin site area. Although the dykes are universally amphibolitized, there are great variations in their deformation state. Several distinct shear-zones of differing width and intensity can be recognized between the south-west edge of the An Ruadh Mheallan enclave and the north-east edge of the main Diabaig Shear Zone, which is situated just south-west of Loch na Beiste (Figure 3.29). A crude estimate of the amount of strain in the dykes can be obtained from the ellipsoidal shapes of the grain aggregates making up the deformed ophitic texture. Niamatullah and Park (1990) used these aggregates as strain markers to map the Laxfordian strain variations across the area. The orientation of the lineation, which at high strains lies close to the shear direction, can also be used to indicate the shear direction within the shear zones. This elongation lineation varies across the area but typically plunges at moderate angles towards the east or ENE, obliquely down the dip of the foliation. The narrow shear-zones generally dip at moderate to steep angles to the north-east, whereas the foliation in the Diabaig Shear Zone dips at 40°–50° to the north-east, becoming less steep to the south-west towards the coast. Based on studies of the orientation of the planar and linear fabrics in relation to the dyke margins, Wheeler *et al.* (1987) recorded both dextral-normal and sinistral-reverse senses of movement on the small shear-zones, but the main Diabaig Shear Zone appears to have a dextral-normal sense (Park *et al.*, 1987). Wheeler *et al.* (1987) suggested that the local Laxfordian shear-zone pattern was influenced by the orientation of the Scourie dykes, which acted as weak zones focusing the strain and movement. They proposed that the regional Laxfordian shearing was possibly top-to-the-W, considerably different from the smaller-scale shear-zone geometry that reflected areas of low strain, the pre-existing Inverian structures, and mafic dyke abundance and orientation.

Minor folds that affect the planar fabric in the dykes are found in some areas, but are generally uncommon. Laxfordian fabrics result in recrystallization of the amphibolite without retrogression, but in some cases a new fabric, attributed to the second Laxfordian deformation, is developed. Younger folds, generally with steep axial planes, are accompanied by retrogressive effects and are attributed to the third Laxfordian deformation.

Interpretation

The structural relationships of the gneisses and dykes seen on a traverse between An Ruadh Mheallan in the north-east and Loch Shildaig in the south-west allow a sequence of metamorphic events to be established. The earlier part of this sequence can be seen near An Ruadh Mheallan. Here, the oldest rocks are mafic sheets and lenses, generally composed of amphibolite, but including the northerly Loch na h-Uamhaig metaperidotite. The mafic and ultramafic rocks are enclosed in, and veined by, tonalitic and granodioritic material, which is deformed by a steep, N-trending foliation. The events leading up to this Badcallian deformation and metamorphism are attributed to the Scourian.

To the south-west the Badcallian foliation is deformed, resulting in folding and a steep, NW-trending foliation, attributed to the Inverian event. However, over much of the area, the intensity of the later Laxfordian deformation, and its similarity in trend to the Inverian structures, make distinction between Inverian and Laxfordian structures difficult. Nevertheless, from scattered observations across the Laxfordian belt, Park *et al.* (1987) concluded that the whole area south-west of An Ruadh Mheallan had been affected by Inverian deformation and lay within a wide Inverian shear-zone that extended to the present limit of the Lewisian Gneiss Complex outcrop south of Loch Torridon.

The Inverian structures are cut in turn by the Scourie dykes, which provide the clearest record of the effects of Laxfordian deformation. Indeed, Wheeler *et al.* (1987) show that the Laxfordian deformation is focused along the dykes, which act as weak roughly planar zones in the banded felsic and mafic gneisses. All the dykes are now amphibolite, indicating that the main (first) Laxfordian event took place under amphibolite-facies metamorphic conditions, but there are major variations in the degree of deformation/reworking. Several distinct Laxfordian shear-zones of variable width, intensity and sense of movement can be recognized, but the dextral-normal sense of the main Diabaig Shear Zone implies that the zone is extensional in its present orientation.

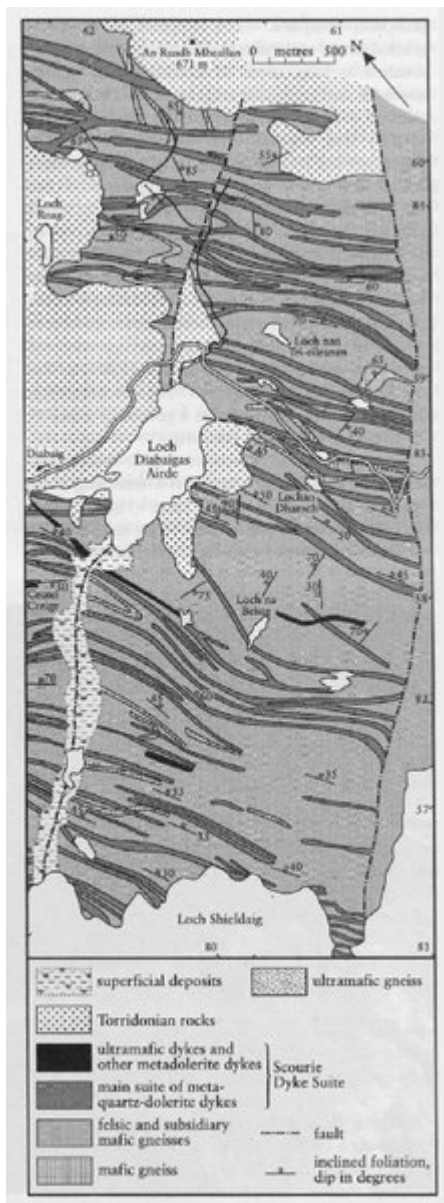
Two subsequent sets of minor folds that affect the planar fabric in the mafic dykes have been correlated with the second and third Laxfordian deformations, the last of which is responsible for major upright NW-trending folds south of Loch Torridon and farther north, in the Gairloch–Loch Maree district.

Conclusions

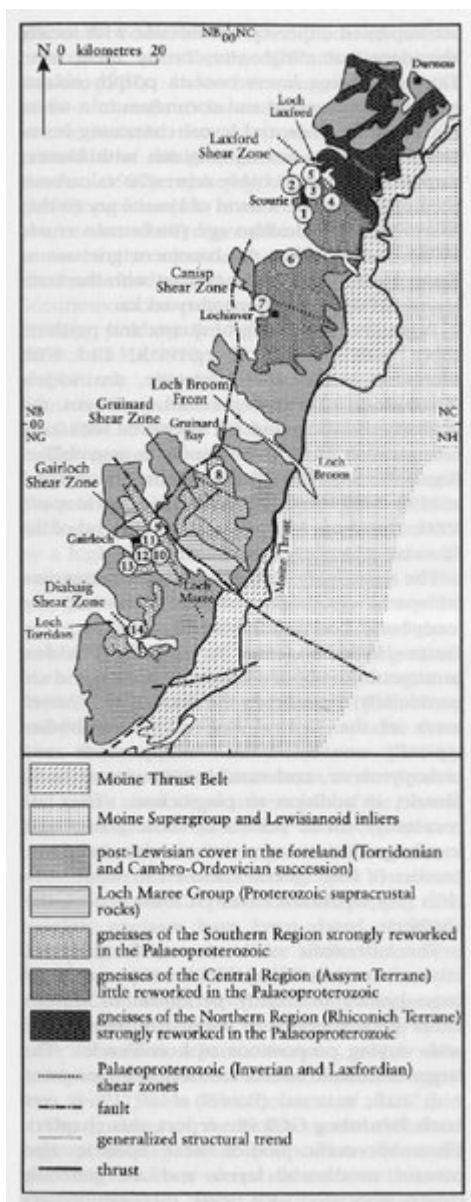
The Alligin GCR site is one of the two classic areas where the original orogenic classification of the Lewisian Gneiss Complex into Scourian and Laxfordian components was formulated by Sutton and Watson (1951). It lies astride the road from Torridon to Diabaig and provides a complete and excellently exposed c. 6 km-long traverse from the An Ruadh Mheallan enclave in the north-east, where the Scourian gneisses show only the effects of the Badcallian tectonothermal event, to the strongly deformed Laxfordian belt of Diabaig (part of the major Diabaig or Torridon Shear Zone) in the south-west. In the An Ruadh Mheallan enclave, the pre-dyke structural history has been established, leading to the recognition of a sequence of Badcallian and Inverian events prior to Scourie dyke emplacement. By noting the deformation patterns of the Scourie dykes and in the Scourian gneisses south of An Ruadh Mheallan, the effects of the Laxfordian event can be demonstrated. Several narrow Laxfordian shear-zones of varying width and intensity can be studied in the transitional zone between An Ruadh Mheallan and the main Diabaig Shear Zone and their sense of movement can be worked out. This area contains some of the best localities in Britain for the study of ductile shear-zones.

The Alligin site is of international importance, both in terms of the quality of exposure, its geological features, historical significance and its suitability for teaching and further research.

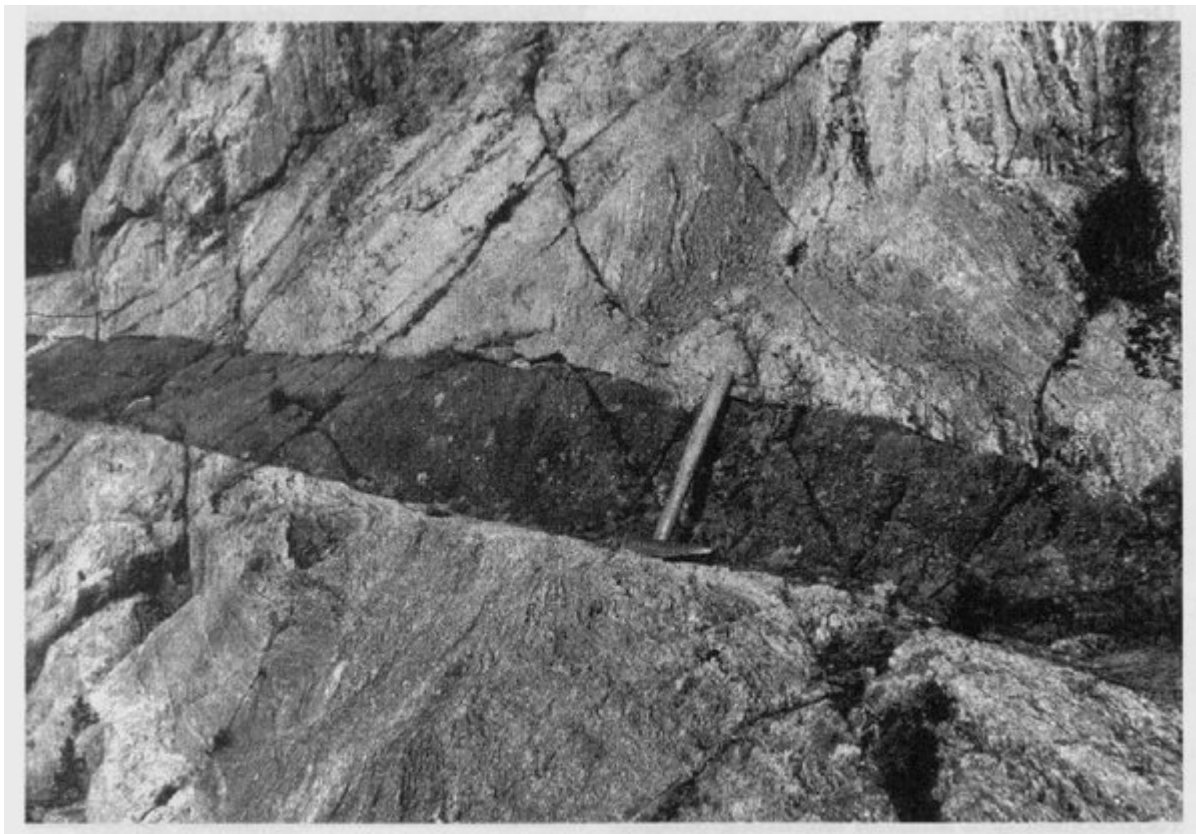
[References](#)



(Figure 3.29) Map of the Alligin (Diabaig) GCR site. After Cresswell (1972).



(Figure 3.1) Simplified map of the Lewisian Gneiss Complex of mainland Scotland. GCR sites: 1— Badcall; 2 — Scourie Mor; 3 — Sithean Mar; 4 — Scourie Bay; 5 — Tarbet to Rubha Ruadh; 6 — Loch Drumbeg; 7 — An Fharaid Mhòr to Clachtoll; 8 — Grainard River; 9 — Creag Mhor Thollaidh; 10 — Kerrysdale; 11 — Flowerdale; 12 — An Ard; 13 — Loch Braigh Horrisdale to Sidhean Mòr; 14 — Alligin (Diabaig). After Park and Tarney (1987).



(Figure 3.30) Thin, undeformed Scourie dyke cutting Badcallian banded gneiss on the south-west slopes of An Ruadh Mheallan. The hammer is 37.5 cm long. (Photo: R.G. Park.)