Creag Mhòr Thollaidh

[NG 827 756]–[NG 863 785]

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Introduction

This large site, between Gairloch and Loch Maree, contains the best-exposed and most accessible section across the 'Tollie Antiform' (Figure 3.18). It was here that C.T. Clough, who first surveyed the area for the Geological Survey in 1889–1890, demonstrated that the gneisses, together with the cross-cutting mafic dykes of the Scourie Dyke Suite, have been deformed into a large-scale antiform. Individual mafic dykes can be traced continuously from the northeast limb of the fold, where they dip steeply to the north-east, through a near-horizontal attitude on the crest of the antiform, to a steep south-westerly dip on the south-west limb. Farther north-east across the trace of a complementary synform, on Creag Mhòr Thollaidh itself, the Scourie dykes are least deformed and pre-dyke Badcallian and Inverian structures can be clearly demonstrated in the gneisses.

The site also includes the north-east margin of the regional Gairloch Shear Zone. A series of exposed outcrops that traverse across the shear zone enable its geometry and the direction and sense of movement across the zone to be worked out. The degree of Laxfordian deformation increases south-westwards across the antiform until, on the south-west limb of the fold, both dykes and gneisses are highly flattened and sheared, with a strong NW-plunging lineation, and all the pre-existing structures converge into parallelism with the intense, steeply dipping, NW-trending foliation.

The area was described by Clough in Peach *et al.* (1907) and was remapped with a revised structural interpretation by Park (1970). Details are given in the memoir on the Lewisian geology of the Gairloch area (Park, 2002).

Description

The Creag Mhor Thollaidh GCR area extends over an area of *c.* 8 km^2, extending south-west from Loch Maree and Tollie Farm to Meall Fuaraidh. Loch Tollaidh marks its northern extent, and Loch Airigh a' Phuill its southern extent. This glacially scoured area lies mainly between 150 m and 350 m above OD and its ubiquitous rocky outcrops are dissected by numerous ridges and gullies and peppered by lochs and lochans. Creag Mbar Thollaidh reaches 343 m above OD and Meall Fuaraidh 369 m, but several summits rise above 340 m. In general the topographical features trend either northwest, reflecting the dominant gneissic banding orientation and major lithological units, or north-east, reflecting a prominent fracture set. The only significant exception is the N-trending valley of the Allt an Leth-chreige, which has been eroded along a zone of cataclastic rocks. Unfortunately large parts of the area have been planted recently with conifers, making it more difficult to access.

The country rocks are amphibolite-facies, felsic (quartzofeldspathic) gneisses with layers and lensoid masses of amphibolite ('early basic' rocks). In the central part of the area these gneisses are generally granodioritic biotite gneisses, whereas in the east, on Creag Mhor Thollaidh, they are typically tonalitic to dioritic, hornblende-bearing gneisses. The mafic dykes of the Scourie Dyke Suite are all metamorphosed to amphibolite facies, but are variably deformed. The Aundrary basite', in the southwest part of the site, is an amphibolitic mafic body that is part of the Palaeoproterozoic Loch Maree Group (see Kerrysdale and Flowerdale GCR site reports, this chapter), and is therefore younger than the adjoining gneisses. However the original relationship between these supracrustal rocks and the basement gneisses has been obscured by intense deformation along a narrow brittle–ductile Laxfordian shear-zone, which lies along the contact.

The site falls into three distinct areas (Figure 3.18): (1) Creag Mhor Thollaidh in the northeast; (2) the Tollie Antiform in the central part of the site; and (3) the steep south-west limb of the Tollie Antiform that forms the north-east margin of the Gairloch Shear Zone, in the south-west.

Area 1: north-east

The track leading south from the A832 main road, 1 km east of the eastern end of Loch Tollie, follows a wide cataclastic zone, the Leth-chreige 'crush belt', which separates the Creag Mhòr Thollaidh block to the east from the Tollie Antiform to the west. This zone contains schistose cataclastic gneisses and breccias veined by pseudotachylite. Excellent exposures of these cataclastic rocks occur in the crags on the east side of the track after it crosses the Tollie stream, 1400 m from the road [NG 860 775]. On the cliff face of Creag Mhòr Thollaidh to the east of the track, the cataclastic rocks dip eastwards at about 30° beneath the steeply dipping gneisses that form the summit of the hill.

On the top of the rocky crags of Creag Mhor Thollaidh, about 2 km from the road and above a small loch [NG 862 770], is an area of medium-to coarse-grained, quartz-plagioclase-hornblende gneisses cut by four Scourie dykes that range from 20 m to 60 m wide. The gneisses have a strongly developed, NW-trending, steep foliation, which is locally cross-cut by the dykes. The mafic dykes have narrow chilled margins and exhibit relict ophitic textures. All four dykes trend north-west, but when followed northwestwards, they are folded and bend through 90° into a north-easterly trend before ending within the crush belt. In the hinge area of this fold, the dykes appear to be unfoliated on the flat glaciated surfaces, but in vertical sections, a strong linear fabric plunging steeply to the south-east is evident. Away from the fold hinge, the dykes are generally weakly foliated sub-parallel to their margins. The gneissose foliation also bends round with the dykes, but in addition it is affected by small-scale folding accompanied by a new NW-trending planar fabric. The main fold, a synform, has a steep south-easterly plunge, a N- to NNE-trending axial trace, and its moderately dipping western limb is also the eastern limb of the Tollie Antiform (Figure 3.18).

Area 2: central

The geology of the central part of the site is best viewed by traversing south-westwards starting from a point 400 m south of the eastern end of Loch Tollie, and following a line of low crags along the south-east side of the loch to the summit of the prominent hill (239 m) at [NG 846 778]. At the north-eastern end of this traverse, steep NW-trending gneissose banding, modified by Inverian deformation, is affected by tight folds with subhorizontal axial planes and a locally developed, gently dipping to subhorizontal foliation that is absent from the eastern part of the site. The intersection of these structures produces a prominent, gently 8-plunging, rodding lineation, which is characteristic of the Tollie area (Figure 3.19). The gneisses are cut by amphibolitized Scourie dykes that are generally concordant with the banding, but show rapid changes in dip from steep to shallow in such a way that the dykes step progressively upwards and westwards. The gently dipping foliation affects the dykes in the shallow-dipping sections, but in some steep sections it appears to stop at the dyke margins and deformation is represented within the dykes by a linear fabric. Examination of the shapes of the deformed felsic grain aggregates in the dykes shows that they are strongly elongated parallel to the S-plunging lineation.

Towards the top of the hill, the gently dipping foliation becomes generally developed, and the mafic dykes appear sill-like. Around the summit, about 100 m above the loch, two thick sills and a thinner sill above them are arched over the crest of the Tollie Antiform. The sills are foliated parallel to their margins, concordant with the gently dipping foliation in the gneisses, but are discordant to the older, steep, Inverian banding. On the south-west side of the hill, both dykes and foliation steepen abruptly to dip about 60° to the south-west. Several K-feldspar-rich pegmatite sheets cut the gneisses and dykes in this area but are affected by the strong shearing in the south-west limb of the antiform.

Area 3: south-west

The south-western area continues the above traverse from the south side of Loch Laraig [NG 846 770], up the slopes of Meallan Mhic Aonghais (367 m), towards Meall Fuaraidh [NG 832 758]. From Loch Laraig to Meallan Mhic Aonghais, granodioritic gneisses are strongly flattened and sheared, and exhibit a prominent lineation. This lineation is contiguous with that described in Area 2 and plunges gently south-east near the hinge of the Tollie Antiform. However, about 600 m south-west of Loch Laraig, the lineation passes through the horizontal to plunge moderately north-west, an orientation that is then maintained for over 1 km in the felsic gneisses and into the northeastern part of the Aundrary 'basite'.

The rocky ridge of Meall Fuaraidh is composed of a 600 m-thick sheet of amphibolite (the Aundrary 'basite) which forms part of the supracrustal Loch Maree Group. Most of the amphibolite is now well-foliated hornblende schist, but there is a central unit of more-massive metagabbro with a coarse relict igneous texture. The NW-plunging lineation, which is characteristic of the Gairloch Shear Zone, appears to stop at the edge of this massive unit and is replaced farther south-west by the earlier SE-plunging linear structure typical of the Gairloch metasedimentary rock belt (see Kerrysdale and Flowerdale GCR site reports, this chapter). The contact between the 'basite' and the highly sheared gneisses of the southwest limb of the antiform is coincident with a brittle–ductile shear-zone, the Creag Bhan Belt. This NW-trending zone, up to 100 m wide, consists of mylonitic gneisses and cataclastic rocks that dip steeply to the south-west. The gneisses are variably retrogressed to greenschist facies both within and adjacent to this belt.

Interpretation

In the north-east part of the GCR site the Badcallian gneisses are typically affected by a strongly developed, steeply dipping foliation, which is cross-cut by numerous thick mafic dykes of the Scourie Dyke Suite. Thus, the foliation is interpreted as being of Inverian age and in this area there is little sign of later Laxfordian deformation. Indeed, around the summit of Creag Mhòr Thollaidh this Inverian foliation wraps around an enclave in which the earlier NE-striking Badcallian foliation is dominant. Here, the Scourie dykes also trend north-east, generally concordant with the earlier foliation. However, on the western limb of the synform that crops out to the south-west of Creag Mhor Thollaidh, a gently dipping foliation affects both the dykes, which here are sill-like, and the gneisses, and is ascribed to early-Laxfordian shearing. The synform folds the gneissose banding and the dykes, with the development of a new axial-planar fabric, and is considered to belong to the second phase of Laxfordian folding, which took place under amphibolite-facies metamorphic conditions. Farther to the south-west, on the south-west limb of the Tollie Antiform, the rocks exhibit much higher Laxfordian strains; the gneissic banding is attenuated and recrystallized and a NW-plunging lineation is developed. This lineation is characteristic of the most highly strained parts of the Gairloch Shear Zone, and was interpreted by Odling (1984) as indicating a dextral, oblique, NE-up sense of shear. The north-eastern margin of the shear zone is taken as the hinge line of the Tollie Antiform, which is interpreted as a related structure. Hence, both the main shearing and formation of the antiform are attributed to the late-Laxfordian deformation event.

An imprecise Rb-Sr age of 1663 ± 22 Ma was obtained from pegmatites of the Tollie area by Holland and Lambert (1995), and a more-precise date of 1694 ± 5 Ma has been obtained by Park *et al.* (2001) using the U-Pb dating method on zircons from the pegmatites. Since the pegmatites are affected by the Gairloch Shear Zone, but cut the folded Scourie dykes, this date can be used to set a lower limit on the age of the first two, higher-grade, Laxfordian events, and an upper limit on the age of the late-Laxfordian Gairloch Shear Zone and Tollie Antiform. As the late-Laxfordian deformation has been dated at *c.* 1670 Ma throughout the mainland Lewisian and in the Outer Hebrides (Corfu *et al.,* 1994; Kinny and Friend, 1997; Kinny *et al.,* 2005), it appears that this deformation event was widespread and pervasive over the whole of the Lewisian Gneiss Complex.

Conclusions

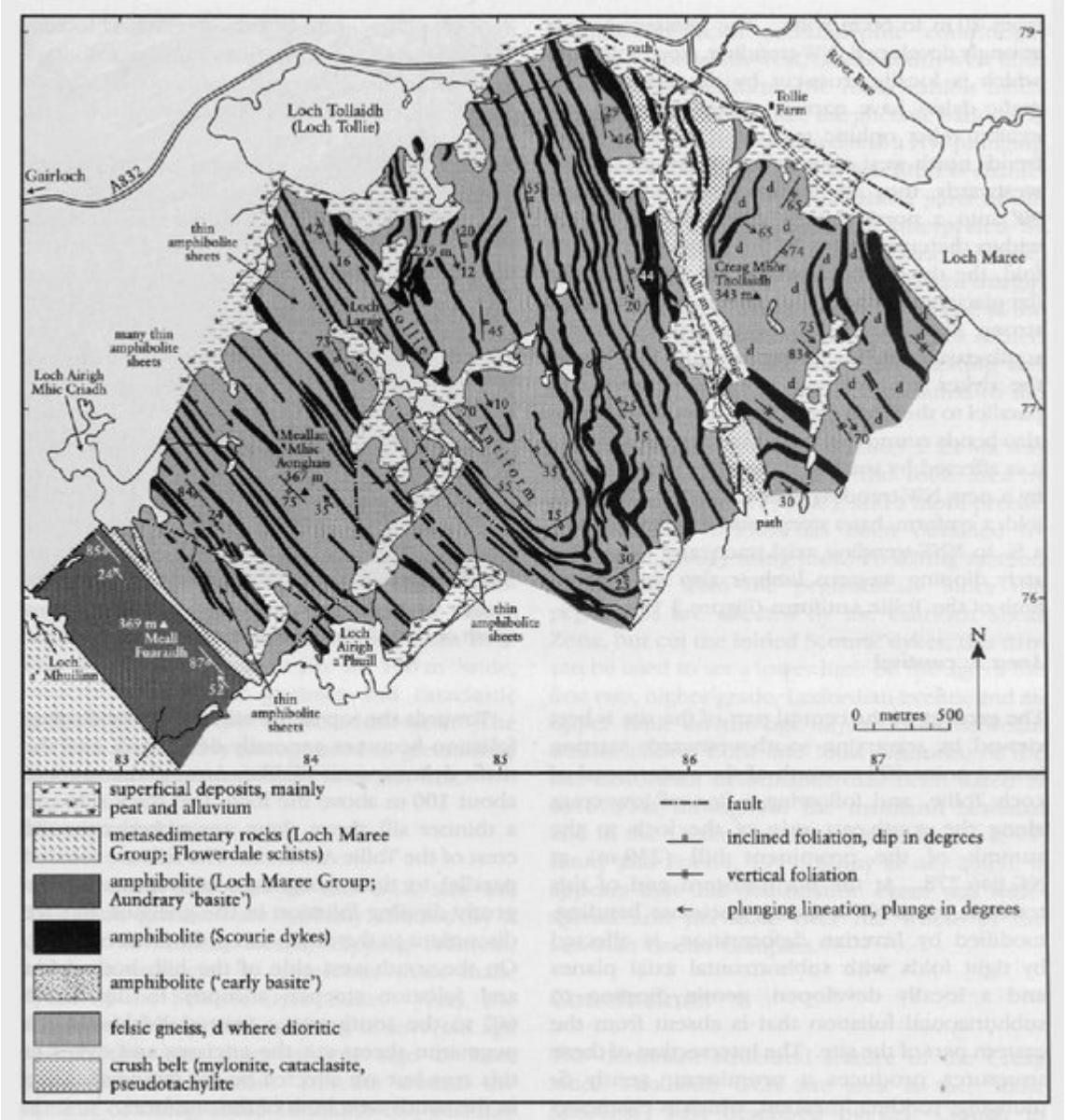
The dominant structural feature of the Creag Mhor Thollaidh GCR site area is the 'Tollie Antiform', first described by C.T. Clough in Peach *et al.* (1907). The area also shows the link, first demonstrated by Odling (1984), between this antiformal structure and the regional, Laxfordian, Gairloch Shear Zone. The Tollie area offers perhaps the best example in the British Isles of how a set of dykes may be used as structural markers to elucidate a geometrically complex structure and unravel the complicated sequence of events represented within a basement gneiss terrain.

These structures can be observed by making a coherent traverse from north-east to south-west, across the exposed ground. On Creag Mhor Thollaidh itself Archaean features of the felsic and mafic gneisses are locally visible and the Scourie dykes cross-cut the generally steep Inverian foliation. On the north-eastern limb of the Tollie Antiform, a gently dipping early-Laxfordian foliation affects both the Scourie dykes, which become sill-like, and the earlier gneisses. The sill-like dykes then arch over the crest of the Laxfordian Tollie Antiform and, within a short distance, become steeply dipping to the south-west. This south-western limb of the antiform exhibits much higher Laxfordian strain; the gneisses are flattened and recrystallized, and a new NW-plunging linear structure is developed, which marks the movement

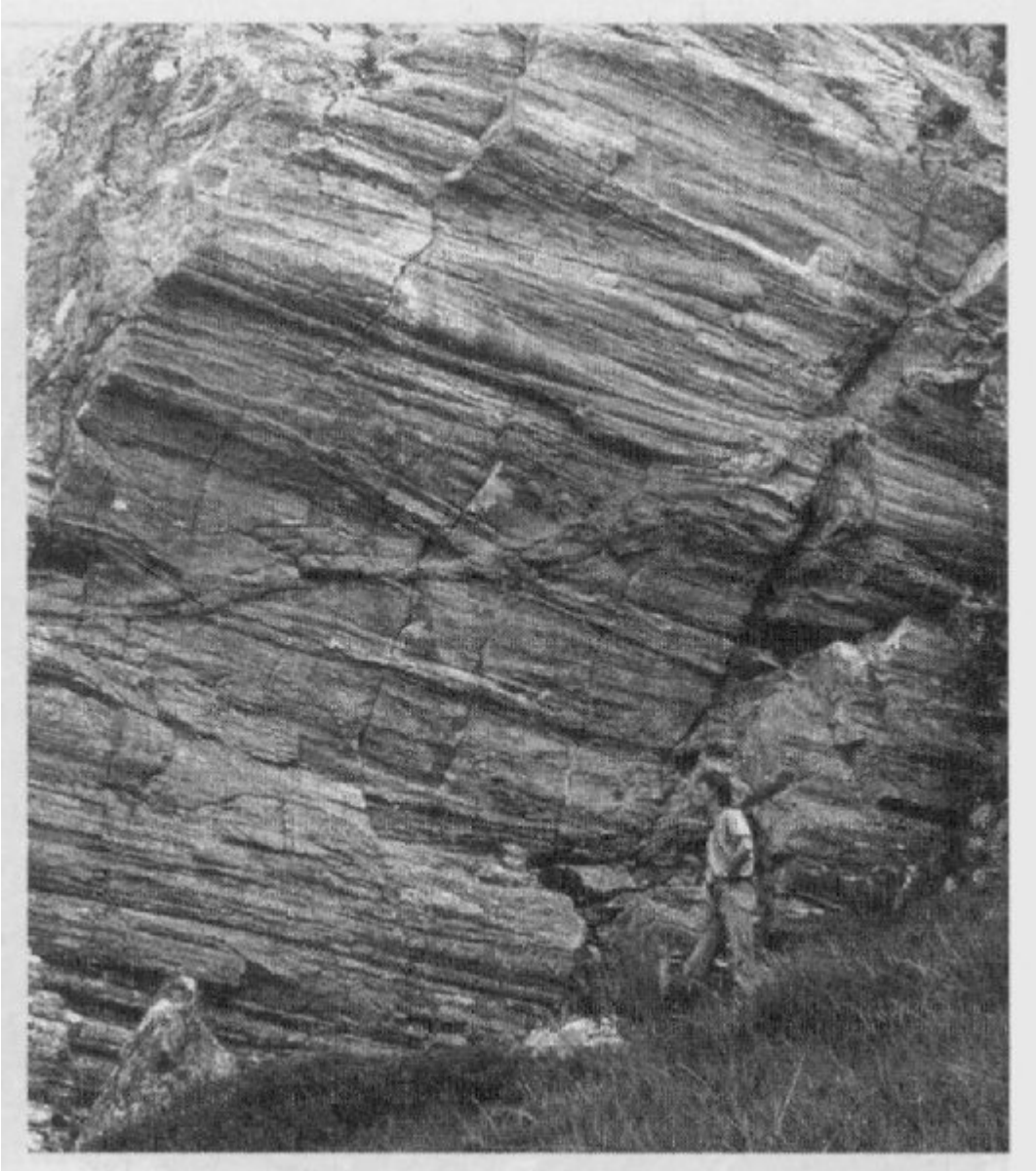
direction on the late-Laxfordian Gairloch Shear Zone.

The Creag Mhor Thollaidh area is a classic Lewisian area and is of national, and possible international, importance, frequently visited by geologists and used by student parties for mapping exercises.

References



(Figure 3.18) Map of the area between Meall Fuaraidh and Creag Mhor Thollaidh. After Park (2002).



(Figure 3.19) Gently plunging rodding lineation, south of Loch Tollie. (Photo: R.G. Park.)