Tarbet to Rubha Ruadh

[NC 174 506]–[NC 158 480]

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Introduction

The Tarbet to Rubha Ruadh GCR site on the south side of the entrance to Loch Laxford provides a classic section across the 'Laxford Front' that separates largely unmodified Archaean basement gneisses to the south from Proterozoic reworked gneisses to the north. This orogenic division of the Lewisian Gneiss Complex into 'Scourian' and 'Laxfordian' components, respectively, was first recognized by Peach *et al.* (1907), but it was Sutton and Watson (1951) who established the significance of the Scourie Dyke Suite as an effective 'stratigraphical marker' separating the two major tectonometamorphic events in the basement gneisses. Sutton and Watson recognized four of the major tectonic zones in this area, which they termed the 'Scourie', 'Claisfearn', 'Foindle' and 'Badnabay' zones. The Scourie Zone consists of Badcallian gneisses cut by undeformed Scourie dykes; the Claisfearn Zone corresponds to the margin of a major, steep, Inverian shear-zone, in which Laxfordian effects are locally developed; the Foindle Zone marks the southern margin of penetrative Laxfordian deformation and metamorphism; and the Badnabay Zone contains Laxfordian granite sheets and exhibits later Laxfordian deformation. The site provides a traverse, which illustrates a progression through the main Proterozoic events that affected the Lewisian Gneiss Complex of the mainland.

The area was first mapped meticulously by C.T. Clough in 1887 and was described by him in Peach *et al.* (1907). Subsequent work by Sutton and Watson (1951), and detailed structural studies by Beach *et al.* (1974), Coward (1990), and Wynn (1995) have added considerably to our understanding of the area.

Description

This rugged GCR site extends from *c.* 1 km south of the fishing hamlet of Tarbet northwards to the peninsula of Rubha Ruadh, a total distance of some 3.7 km. The excellent exposure is due to a combination of attack by Atlantic storms along the western coastal section and severe glacial scouring inland. The site includes several rocky knolls, the highest being Cnoc Gorm at 133 m [NC 163 495], commonly separated by small lochans. The generally WNW-trending rocky ridges and hollows give the area a pronounced topographical grain that reflects the overall banding and foliation in the gneisses.

In the southern part of the site area a thick, undeformed Scourie dyke cross-cuts Badcallian gneisses that generally dip moderately to the south-west (Figure 3.8). This corresponds to the 'Scourie Zone' of Sutton and Watson (1951). About 1 km south of Tarbet is the southern margin of a large Inverian shear-zone, where the Badcallian gneisses are thinned and steepened into a near-vertical NW-trending orientation and retrogressed to amphibolite facies. Scourie dykes clearly cross-cut the Inverian fabric in this zone; although they are affected in turn by small-scale, narrow Laxfordian shear-zones. An excellent example of an irregular discordant dyke may be examined on the coast, on the south side of Port Mor (see (Figure 3.9)). A narrow, steeply S-dipping, Laxfordian shear-zone with a WNW–ESE trend is well exposed on the top of the hill on the south side of Port of Tarbet, where it cuts a Scourie dyke. The shear zone exhibits a prominent lineation plunging at 45° to the south-east, implying a sinistral, north-up sense of movement.

Immediately north of Port of Tarbet (Figure 3.8), is a thick sequence of finely interbanded felsic and mafic gneisses containing several bands of brown-weathering, flaggy to fissile, schistose garnet-biotite-plagioclase semipelite and some quartzose psammite units, interpreted to be of sedimentary origin. Farther north is a coarse-grained, foliated granitic sheet containing a muscovite-K-feldspar-plagioclase-quartz assemblage. Good exposures of closely foliated, highly strained gneisses displaying abundant tight to isoclinal folds and a moderately SE-plunging lineation occur at the top of Cnoc Poll an Turrabain, about 500 m north of Tarbet. Here the foliation in the gneisses trends north-westerly and dips steeply to the south-west. This foliation must result from Inverian reworking, as farther north-west it is cut by a discordant

thick Scourie dyke that is well exposed on the coastal rock platform north of Poll an Thrrabain at [NC 161 497] (Figure 3.10). The dyke can be traced across the promontory of Rubh' an Tiompain to the north-west, but it lenses out rapidly to the south-east; the dyke geometry is thought to reflect its original intrusive form rather than the later deformation. The dyke is composed of three intermixed igneous components: 'normal' metadolerite, a more-felsic type and a more-mafic type. It contains numerous xenoliths and also exhibits mafic–felsic segregation banding of presumed igneous origin. Although the dyke shows weak to moderate internal fabric development it also contains numerous narrow Laxfordian shear-zones marked by an intense foliation. Its southern contact can be clearly seen to be discordant to the Inverian gneissose foliation, which is also present within the gneiss xenoliths.

About 1 km north of Tarbet, the ridge of Cnoc Gorm consists of a thick sheet of banded garnetiferous metagabbro, which trends in a WNW direction to the coast. This is one of several mafic bodies found in this area that preserve their original Badcallian mineral assemblages. Still farther north, west of Fanagmore, a thinner sheet consisting of both mafic and ultramaflc material, accompanied by brown-weathering schists, forms a complex series of folds with NW-trending axes (Figure 3.8). These folds are cut by a thin, NW-trending, Scourie dyke, which, farther north-west, is itself folded by Laxfordian structures. The pre-dyke folds are thus of Inverian age. The Laxfordian deformation here is more intense and pervasive than farther south, and marks the transition from the Claisfearn Zone into the Foindle Zone.

The most northerly part of the area, at Rubha Ruadh, is marked by a prominent 150m-wide sheet of granite that trends in a north-westerly direction across the peninsula. The southern margin of the granite is sharp, though concordant, and separates the Foindle Zone to the southwest, where granite sheets are minor and uncommon, from the Badnabay Zone to the north-east, where pink to red granite sheets and white pegmatitic veins make up much of the outcrop. This boundary is known as the laxford Front' and marks the south-west margin of a zone along which the granite sheets have been concentrated. The granites are typically foliated and contain pegmatitic segregations. They occur as a number of discrete sheet-like bodies separated by biotitic and hornblendic felsic gneisses. The gneisses of the Badnabay Zone (and also those farther north) have been shown by Holland and Lambert (1973) to be chemically distinct from those of the Central Region.

Interpretation

The Tarbet to Rubha Ruadh GCR site provides a traverse up to the 'Laxford Front' from which inferences about the nature and tectonic history of the Lewisian Gneiss Complex can be drawn. The Claisfearn and Foindle zones represent a major, steep Inverian shear-zone, in which the original Badcallian gneisses, which occur in the Scourie Zone farther south, have become deformed, folded and retrogressed to amphibolite facies. Sutton and Watson (1951) interpreted the reworking of the Badcallian gneisses in these zones as a result of Laxfordian effects, but Beach *et al.* (1974) showed that the reworking was Inverian. From the sense of shear and the lineation direction within the high-strain parts of this shear zone, a dextral, south-up sense of movement (i.e. overthrusting from the south) can be inferred.

The Foindle and Badnabay zones represent the southern part of a major Laxfordian shear-zone, which is superimposed upon the earlier Inverian shear-zone. The Foindle Zone defines the northern margin of the Central Region of the Lewisian Gneiss Complex, and here Laxfordian deformation is weak and localized. The discrete narrow shear-zones that affect the Scourie dykes to the south are replaced here by pervasive Laxfordian deformation. The deformation is manifest as an intense NW-trending, steeply SW-dipping foliation and a SE-plunging lineation, whose orientations are similar to those of the Inverian shear-zone immediately to the south. According to Wynn (1995) the movement on the main Laxfordian shear-zone was dextral, and transpressional, but was accompanied to the south-west by a suite of second-order E- to NE-trending shears along which a sinistral trans-tensional sense of movement can be inferred, as in the minor shear-zones near Tarbet.

Isotopic dating was initially carried out in the area by Lyon *et al.* (1975), who obtained a Rb-Sr whole-rock isochron age of 2745 Ma (i.e. Badcallian) from the gneisses and a whole-rock–muscovite isochron age of *c.* 1750 Ma (i.e. Laxfordian) from a granitic sheet north of Port of Tarbet. These ages were taken to indicate that the rocks formed during the Badcallian event, but were reworked during the Laxfordian. More recently, Kinny and Friend (1997) have shown that there appears to be an abrupt change in the nature of the gneiss basement across the Laxford Front, with gneisses from

the Northern Region having protolith ages of 2840–2800 Ma, whereas those immediately south of the Laxford Front have protolith ages of 3030–2960 Ma. This suggests that the Laxfordian shear-zone situated in the Foindle and Badnabay zones represents a major terrane boundary. Evidence for the metamorphic event at *c.* 2480–2490 Ma, which is recorded from gneisses of the Central Region, is absent from those of the Northern Region (Corfu *et al.,* 1994; Kinny and Friend, 1997). Laxfordian granite sheets that are abundant to the north of the Laxford Front appear to represent several periods of emplacement. Friend and Kinny (2001) showed that the granite at Laxford Bridge was intruded at 1855 Ma, but Goodenough *et al.* (in press) have obtained LA-PIMS and TIMS zircon U-Pb ages of 1880 Ma and 1775 Ma from two distinct sets of granitic intrusions in the Laxford Shear Zone. These granites occur in both the Northern and Central regions (Assynt and Rhiconich terranes), implying their juxtaposition pre-dates the Laxfordian events and is probably of Inverian age.

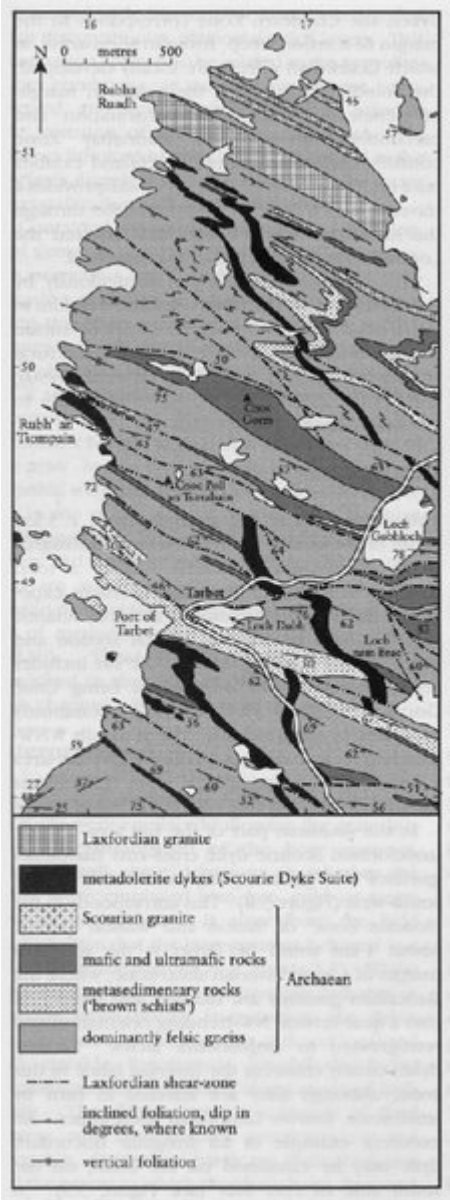
Conclusions

This internationally important GCR site provides a well-exposed traverse from the Central Region northwards across the classic area to the 'Laxford Front'. It was here that Sutton and Watson (1951) originally demonstrated their orogenic division of the Lewisian Gneiss Complex into Scourian and Laxfordian components. The site contains four of Sutton and Watson's five designated tectonic zones, the Scourie, Claisfearn, Foindle and Badnabay zones, and allows the transition to be demonstrated from the Badcallian gneisses in the south, through an Inverian shear-zone in the central part of the area, to the Laxfordian shear-zone in the north.

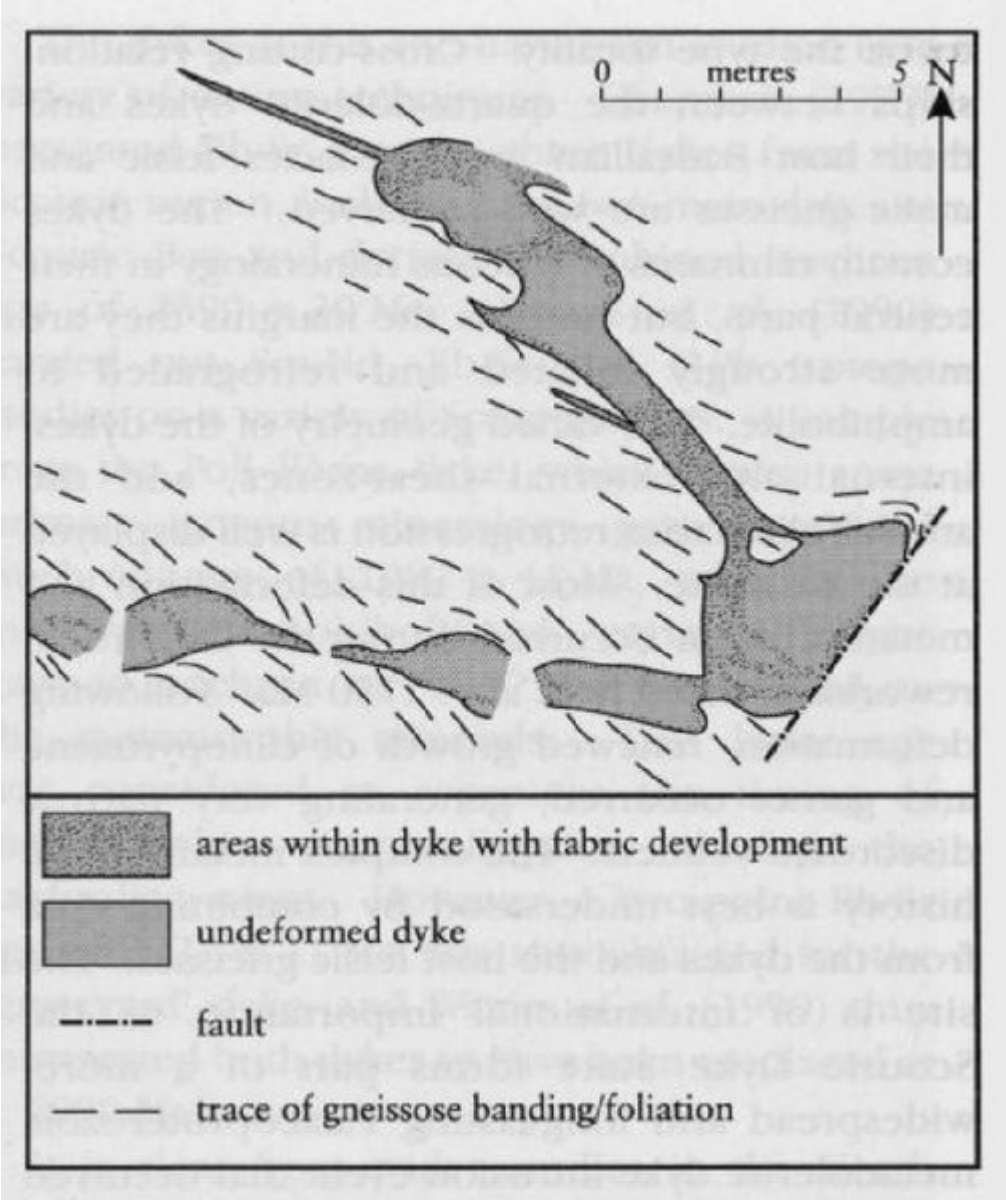
The traverse demonstrates the effects of the reworking of the earlier high-grade Badcallian gneisses during the later amphibolite-facies Inverian event (*c.* 2490 Ma), and subsequently during the amphibolite-facies Laxfordian event *c.* 1740 Ma. The emplacement of the Scourie Dyke Suite, which plays a vital role as a chronological marker, separates these latter two tectonometamorphic events. Recent U-Pb zircon age dates from the area have also clarified the significance of the Laxford Front as a possible terrane boundary.

The Tarbet to Rubha Ruadh site is of international significance in that it forms a 'type area' for demonstrating the tectonic and metamorphic history of the Lewisian Gneiss Complex in Britain, which can be matched and compared to its counterparts in Greenland, North America and Scandinavia. In historical terms, the Scourie–Laxford area was one of the first places where tectonic events in a basement gneiss complex were separated using an episode of igneous intrusion in order to create a 'pseudo-stratigraphy'. Similar methods have subsequently been widely used in other basement ten¯rains and are now a standard tool in unravelling complex sequences of events around the world.

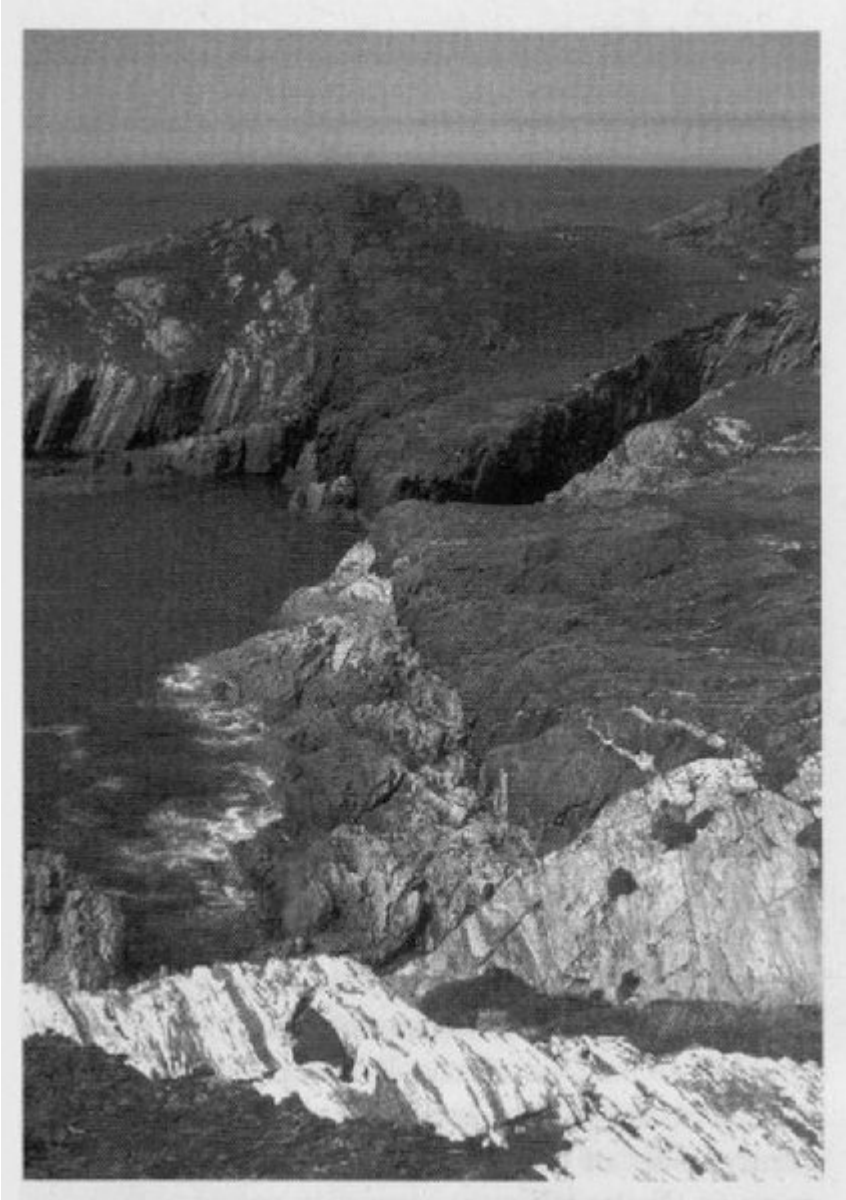
References



(Figure 3.8) Map of the Tarbet to Rubha Ruadh area. Based on Beach (1978), Coward (1990), and Geological Survey 1:10 560 Sheet Sutherland 30 (1913).



(Figure 3.9) Map of an irregular Scourie dyke south of Tarbet. Areas in the dyke with a fabric are stippled, undeformed portions are blank. The discordance with the banding in the gneisses is shown. After Beach (1978).



(Figure 3.10) Thick Scourie dyke cutting discordantly across banded, mainly felsic gneisses by Rubh' an Tiompain. The dyke is internally deformed and shows partial amphibolitization. It contains shear zones that are notably abundant near the dyke margins. Its markedly lenticular form is interpreted as an original intrusive feature. (Photo: J.R. Mendum.)