Excursion 5 Glen Moriston and Glen Shiel

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Purpose:	A general excursion across the Sgurr Beag Nappe.
Aspects covered:	Metasedimentary lithologies typical of the Loch Eil and Glenfinnan groups, West Highland Granitic Gneiss, Caledonian (Cluanie) Granite, deformed crossbedding, Sgurr Beag Thrust Zone, Lewisianoid slices.
Maps:	OS: 1:25,000 sheets 414 Glen Shiel & Kintail Forest and 415 Glen Affric & Glen Moriston; BGS: 1:50,000 sheets 72W Kintail, 72E Glen Affric and 73W Invermoriston.
Type of terrain:	Road-side outcrops, a quarry, and some rough hill walking.
Distance and time:	30km driving. 6 hours.
Short itinerary:	Localities 5.2, 5.4A, 5.5A and 5.6A.

The excursion can be commenced by travelling from either Invermoriston or Invergarry. However, a start from Invermoriston is the more convenient if travelling by coach, as it is not then necessary to turn the vehicle at or near to Locality 5.1. To the west of Invergarry and Invermoriston, for many kilometres, the solid geology is dominated by flaggy, generally flat-lying psammitic rocks of the Loch Eil Group. These carry common to abundant thin ribs and lenses of pale-weathering calc-silicate rocks and often contain concordant stripes and bands of meta-igneous hornblende schist. Dykes, sheets and veins of microdiorite, granite and pegmatite represent Caledonian igneous activity.

If travelling from Invergarry, it is worth stopping on the watershed at the scenic viewpoint on the south side of the A87 at [NH 195 035], about 8km west of Invergarry, where there is parking for coaches. There are splendid views from here of the mountains to the west, and individual topographic features are identified on the metal surface of the viewpoint. Looking west, the rounded hilly topography (e.g. Glas Bheinn [NN 134 975]) has been carved from the generally flat-lying psammites of the Loch Eil Group, with their granitic vein complexes. In the distance to the west rise spectacular, craggy and generally higher mountains, such as Gairich, 919m (3015ft) [NN 026 995] and Spidean Mialach, 996m (3268ft) [NH 066 043], marking the steeply inclined, strongly folded, diverse pelitic and psammitic formations that comprise the Glenfinnan Group. These rocks occur to the west of the Loch Quoich Line (Clifford, 1957; Roberts & Harris, 1983) and are described later in this Excursion (Locality 5.5) and also in Excursion 4. The floor of Glen Garry is occupied by Lochs Garry and Poulary.

To reach Locality 5.1 from the scenic viewpoint, continue northwards to the foot of Glen Loyne where the A87 is joined from the east by the A887, and turn right. Drive eastwards along Glen Moriston for approximately 7.5 km. Locality 5.1 is a large cutting on the south side of the road just to the east of an entrance to the forest at [NH 2854 1219]. Parking for a coach or several smaller vehicles is available in the entrance, provided it is not in use at the time. If travelling from Invergarry, it is necessary at this point to turn the coach to face west. This can be accomplished here with care (*note: cars travel fast along this particular section of the A887*), but turning points can also be found further east.

Locality 5.1 – A887 road cutting. [NH 2864 1219]

A887 road cutting (Figure 5.1). Loch Eil Group psammites and veins of late Caledonian granite and pegmatite. [NH 2864 1219]

This locality exposes flat-lying, Loch Eil Group micaceous psammites that are typical of the 'flat-belt' in this part of Inverness-shire. The absence of sedimentary structures in combination with the very flaggy aspect of the psammites probably results from high tectonic strains imposed on these rocks during tight-to-isoclinal D_1 and D_2 fold phases (see also Excursion 4, Locality 4.1; Holdsworth & Roberts, 1984). The alignment of biotite and muscovite sub-parallel to compositional layering is thought to represent a composite S_1/S_2 fabric. Several layers of hornblende schist are present

and are interpreted as early metabasic intrusions that record all the deformation events that have affected their host Moine rocks. The most prominent layer is *c*.2m thick and extends for some distance along the lower level of the cutting. These metamorphic rocks are intruded by numerous coarse-grained, granitic and pegmatitic veins and sheets, varying in width from a few centimetres to 10m at the west end of the locality (Figure 5.2). Some are concordant with the flaggy banding in the Moine rocks, but most are steeply-dipping and strongly discordant. There is no consistent set of crosscutting relationships between these intrusions which appear to have been emplaced more or less contemporaneously. Contacts with the Moine rocks are invariably sharp. There is no sign that any of the intrusive sheets or veins have been affected by any ductile deformation, and they therefore appear to have been intruded post-D_2. These intrusions represent part of the late Caledonian Glen Garry Vein Complex (Fettes & MacDonald, 1979).

En route westwards to Locality 5.2, various road cuttings expose subhorizontal to gently-dipping Loch Eil Group psammites that are similar to those of Locality 5.1. There are few opportunities for parking a coach close to any of these, but small groups in cars or minibuses could park with care on the side of the road if they should wish to inspect any of these exposures. Locality 5.2 lies approximately 5km west of Locality 5.1, on the south side of the A887. Parking is available in a lay-by for a coach or several smaller vehicles on the south side of the road at [NH 2364 1121] adjacent to the memorial to Roderick McKenzie.

Locality 5.2 — A887 road cutting [NH 2348 1115]

A887 road cutting (Figure 5.1). Glen Doe Granitic Gneiss and hornblende schist bodies.

Walk west from the parking place along the extensive road cutting that exposes the Glen Doe Granitic Gneiss, a unit of the regionally extensive West Highland Granitic Gneiss (see also Excursions 2 and 4). The granitic gneiss is grey, medium-grained, and texturally homogenous, and carries a penetrative deformation fabric defined by aligned micas and quartzo-feldspathic aggregates. The planar component is interpreted as a composite S_1/S_2 fabric and is sub-horizontal to gently-dipping. Careful inspection of foliation planes reveals a N-S trending L_2 mineral and extension lineation. The granitic gneiss is intruded by several sheets of hornblende schist that vary in thickness from a few centimetres to one metre. These intrusions carry a penetrative S_1/S_2 fabric defined by aligned hornblende grains, and their margins are sub-concordant with the banding in the host granitic gneiss. Plausible examples occur of mesoscopic D_2 folds of hornblende schists, accompanied by axial-planar S_2 crenulations of S_1. However, in places the original intrusive geometry gives rise to 'pseudo-folds' where hornblende schist sheets bifurcate.

This locality is significant in discussion of the origin of the protolith of the West Highland Granitic Gneiss that was intruded at *c*.870 Ma (Friend *et al*., 1997; Rogers *et al*., 2001). Millar (1999) and Dalziel & Soper (2001) point out that both the Glen Doe Granitic Gneiss and the hornblende schists are structurally indistinguishable in that they have both been deformed by D_1. Barr *et al*. (1985) proposed a syn-D_1/MS_1 age of intrusion of the protolith of the granitic gneiss because of the absence of a distinct thermal aureole within adjacent Moine host rocks. However, in the view of Dalziel & Soper (2001) there is nothing to preclude an entirely pre-D_1 age.

Accordingly, the hornblende schists and the granitic gneisses have been reinterpreted by Millar (1999) and Dalziel & Soper (2001) as a pre-tectonic, bimodal igneous suite. The tholeiitic chemistry of the hornblende schists is consistent with emplacement into thinned continental crust during crustal extension and development of the Moine sedimentary basin (Millar, 1999). Melting of Moine sediments and/or underlying basement as a result of the advection of heat by emplacement of basaltic magma at deeper crustal levels is thought to have produced the protolith of the granitic gneiss (Dalziel & Soper, 2001; Ryan & Soper, 2001). Interested parties may wish to obtain permission from Ceannacroc Lodge to examine further the outcrops of granite gneiss and associated amphibolites and hornblende schists exposed in the River Doe. Publications by Peacock (1977), Millar (1999) and Dalziel & Soper (2001) provide sufficient information and grid references of critical localities.

Locality 5.3 is reached by driving westwards past the junction with the A87. The road then starts to climb towards the dam at the eastern end of Loch Cluanie, a hydroelectric reservoir. The nature of the glacial erratics at the roadside clearly indicates where the route has crossed the eastern margin of the Cluanie Granite; many natural exposures and quarries opened for dam and road construction are available near the road. The steep rocky mountain to the south is made

entirely of Cluanie Granite. The largest of the quarries is recommended as Locality 5.3. Parking is available at the north end of the Cluanie dam for a coach or several smaller vehicles, and access is by a rough quarry track about 300m long. Care should be taken when approaching quarry faces as these may be unstable. Hard hats should be mandatory.

Locality 5.3 — Large quarry to the north of the Cluanie dam [NH 185 103]

Large quarry to the north of the Cluanie dam (Figure 5.1). Cluanie Granite

The Cluanie Granite (Leedal, 1952) is a handsome pink, megacrystic granite comprising quartz + oligoclase + microcline + microperthite + hornblende + titanite. Microcline-microperthite occurs as small megacrysts, while the oligoclase shows spectacular zoning that can readily be seen in hand specimen. Locally, the granite contains hornblende-rich mafic enclaves. There is no sign of any systematic orientation of either the megacrysts or the enclaves. The pluton has yielded a Rb-Sr whole rock isochron of 425 ± 4 Ma (M. Brook, quoted in Pankhurst, 1982), that may approximate to the time of intrusion, but cannot be viewed as definitive. On the north face of the quarry, the granite is cut by a microdiorite sheet that dips southwards at about 60■. Detailed investigation reveals that the margins of the microdiorite sheet are lobate in places, perhaps indicating that it was emplaced into granite that was only partially crystalline at the time of intrusion.

Locality 5.4 lies 6.7km to the west of the Cluanie dam at [NH 1238 1048] where parking is available in a large lay-by on the south side of the A87.

Locality 5.4 Loch Cluanie shoreline [NH 1230 1034]

Loch Cluanie shoreline (Figure 5.1). Sedimentary structures and polyphase folds within Loch Eil Group metasediments.

If water levels in the loch are low, as is commonly the case at the time of writing, walk SE from the lay-by to an obvious promontory on the loch shoreline at Locality 5.4A [NH 1230 1034]. Excellent washed surfaces expose banded psammites and semi-pelites that are probably assignable to the Loch Eil Group. The psammites contain abundant examples of smallscale cross-bedding, and stripes and laminae of micaceous material also assist in defining the original bedding surfaces. Tectonic strain is heterogeneous at this locality and its effect on the original sedimentary structures, therefore, varies. In places, original angles between foreset and topset have been increased by deformation, while elsewhere angles have been reduced such that way-up cannot be reliably read. Numerous folds are present, and the locality is therefore useful not only for demonstrating the effects of strain on sedimentary structures, but also for discussion of facing directions in the axial planes of folds. The difficulty of distinguishing truncated fold limbs from original cross-bedding, a common problem in the Moine, as in other moderately deformed terrains, can also be introduced.

Careful inspection of the surfaces exposed by low water levels indicates that the rocks preserve a polyphase deformation history. Tight-to-isoclinal D_2 folds that carry an axial-planar composite S_1/S_2 fabric are deformed by tight-to-open, steeply-plunging D_3 folds with an axial-planar crenulation fabric (S_3). These folds are of the same age as those that define the Loch Quoich Line (see Excursion 4). The metasediments are intruded by numerous leucocratic segregations and veins; some are parallel to lithological banding whereas others are strongly discordant. The earliest intrusions are rare quartz veins that are folded by the D_2 folds. Most common are quartzo-feldspathic veins that are coarse-grained and may be internally layered. These are clearly deformed by the D_3folds and carry an internal fabric that is axial-planar to these structures. This locality provides numerous instructive examples of the influence of layer thickness on fold wavelength.

Further west along the shoreline at 4B [NH 1242 1038], a prominent knoll exposes a large pod (5m x 4m) of garnet-amphibolite within banded psammitic and semi-pelitic gneisses. The schistose and highly strained margins of the amphibolite pod lack garnet and are dominated by hornblende and biotite. The contact between the metasediments and the amphibolite is deformed by a D_3fold. Within the host metasediments, abundant coarse-grained quartzo-feldspathic veins are deformed by D_3folds. Discordant quartz veins appear to be late to post-D_3.

Return to the lay-by. If the water level in the loch prevents examination of the localities described above, the road cutting opposite the lay-by provides good examples of variably deformed cross-bedding and D_3folds as described above. From Locality 5.4, the excursion passes westwards for about 9.9km into Glen Shiel, passing through rocks of the Glenfinnan Group, exposed in many road cuttings. A general locality in the hillside to the south of the road is recommended as Locality 5.5. A large lay-by, popular with summer visitors, which is part of the old road down Glen Shiel, is large enough for coaches or several cars; it lies on the south side of the main road.

Locality 5.5 Glen Shiel [NH 0266 1234]

Glen Shiel (Figure 5.1). Glenfinnan Group striped rocks and interference structures.

The purpose of this locality is to demonstrate characteristic rock types and deformation style within the Glenfinnan Group. For the faint-hearted, the road cutting on the north side of the A87 opposite forms Locality 5.5A and lies in striped and banded coarse siliceous psammite and coarse pelitic schists, the psammite carries occasional calc-silicate lenses. Folds are clearly seen to plunge steeply and are probably the same age as the D_3folds at Locality 5.4. Caution should be exercised at this locality because of fast traffic and the instability of the high rock face.

The road cutting, although of interest, is considerably less spectacular than Locality 5.5B – the rocks exposed on the hillside some 500m to the south, in the general vicinity of [NH 022 122] that can only be reached with some exertion and difficulty. The exertion derives from the *c.*500m of rough and soggy, moderately inclined moorland leading to the steep hillside whose crags expose the geological features described below. The difficulty lies in crossing two substantial streams that are not bridged in the vicinity but which can be crossed in wellington boots or by nimble footwork when water level is moderate-to-low. In the past, leaders have carried planks to aid the crossing of these streams.

The weathered rock faces and glaciated pavements on the hillside display spectacular folds of both the Loch Quoich Line (D_3) generation and earlier (D_2). The rocks involved are coarse siliceous psammites, disposed as stripes and bands, separated by coarse-grained pelitic and semi-pelitic schists that carry a coarse crenulation and numerous garnet and muscovite porphyroblasts. Locally, lenticles of calc-silicate, up to a metre long and 0.1m across, stand out from the surrounding metasedimentary rock and are readily recognized as being studded with reddish brown garnets up to 5mm across. They consist of garnet, amphibole, calcic plagioclase and quartz. A large range of interference structures can be demonstrated, from simple eye structures to hooked interference patterns. The present distribution of interference structures probably defines the hinge zone of a major fold that predated the imposition of the Loch Quoich Line (D_3) generation of structures. It is inferred that, whereas the D_3 folds are universally developed, the D_2 major folds were long-limbed structures in which minor- and intermediate-scale folds were confined to the hinge zones. Hence the areas in which D_3 folds *only* occur correspond to the D_2 major fold limbs, while the zones of interference correspond to the D_2 hinge zones. The hinges of the D_3folds are spectacularly curvilinear in style with the majority being almost reclined, plunging steeply in a general easterly direction with axial traces trending NNE.

About 2km to the west of the lay-by used for Locality 5.5, lies Locality 5.6 where the Sgurr Beag Thrust Zone may be examined. Locality 5.6 can be easily located in the area next to a well-defined gap some 200m wide between forestry plantations on the right-hand side (north) of the road. A conventional lay-by, part of the old road below the trees, occurs on the north side of the road, but a metal barrier prevents its usage by any vehicles higher than 6 foot 9 inches (~2m).

Locality 5.6 Glen Shiel [NH 006 135], [NH 008 137]

Glen Shiel (Figure 5.1), (Figure 5.3). Sgurr Beag Thrust Zone, Lewisianoid sheet.

This general locality comprises several exposures within the Sgurr Beag Thrust Zone. Two stops will be visited. From the lay-by, cross the road and proceed to the south side of a small knoll at Locality 5.6A [NH 0073 1348]. Here lenticular garnetiferous amphibolite and biotite-hornblende schist are exposed. The foliation within these rock types anastomoses between a series of steeply-dipping, irregular shear zones along which platy quartzo-feldspathic veins occur. Minor crenulations detach along these zones and between them occur rootless fold hinges. These hornblendic rocks form part

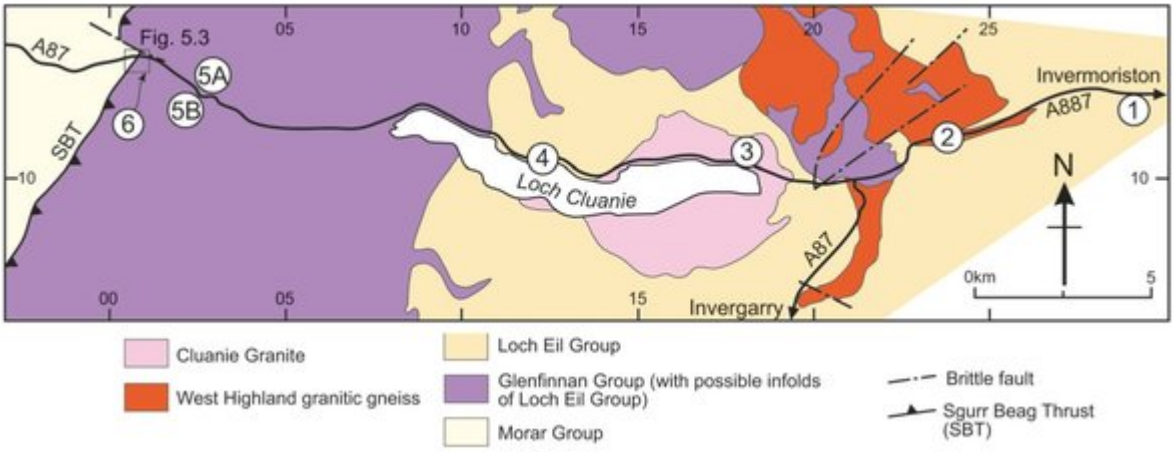
of a thin, but remarkably continuous strip of Lewisian that coincides with the ductile thrust zone separating the Morar and Glenfinnan groups.

Proceed to the river bank [NH 0068 1343]. Next to a small confluence platy gneissose psammites are exposed. These psammites have strong affinities with the Reidh Psammite of Tanner (1971). Westwards toward the thrust, the platy or lenticular gneissose segregation bands are progressively sheared into weakly asymmetric augen. On the south bank of the river [NH 0066 1342] where the surface of *decollement* is clearly exposed, the resultant augen gneiss passes abruptly into platy semi-pelitic schist. The progressive development of feldspar augen from more or less continuous gneissose banding reflects the steep strain gradient above the thrust.

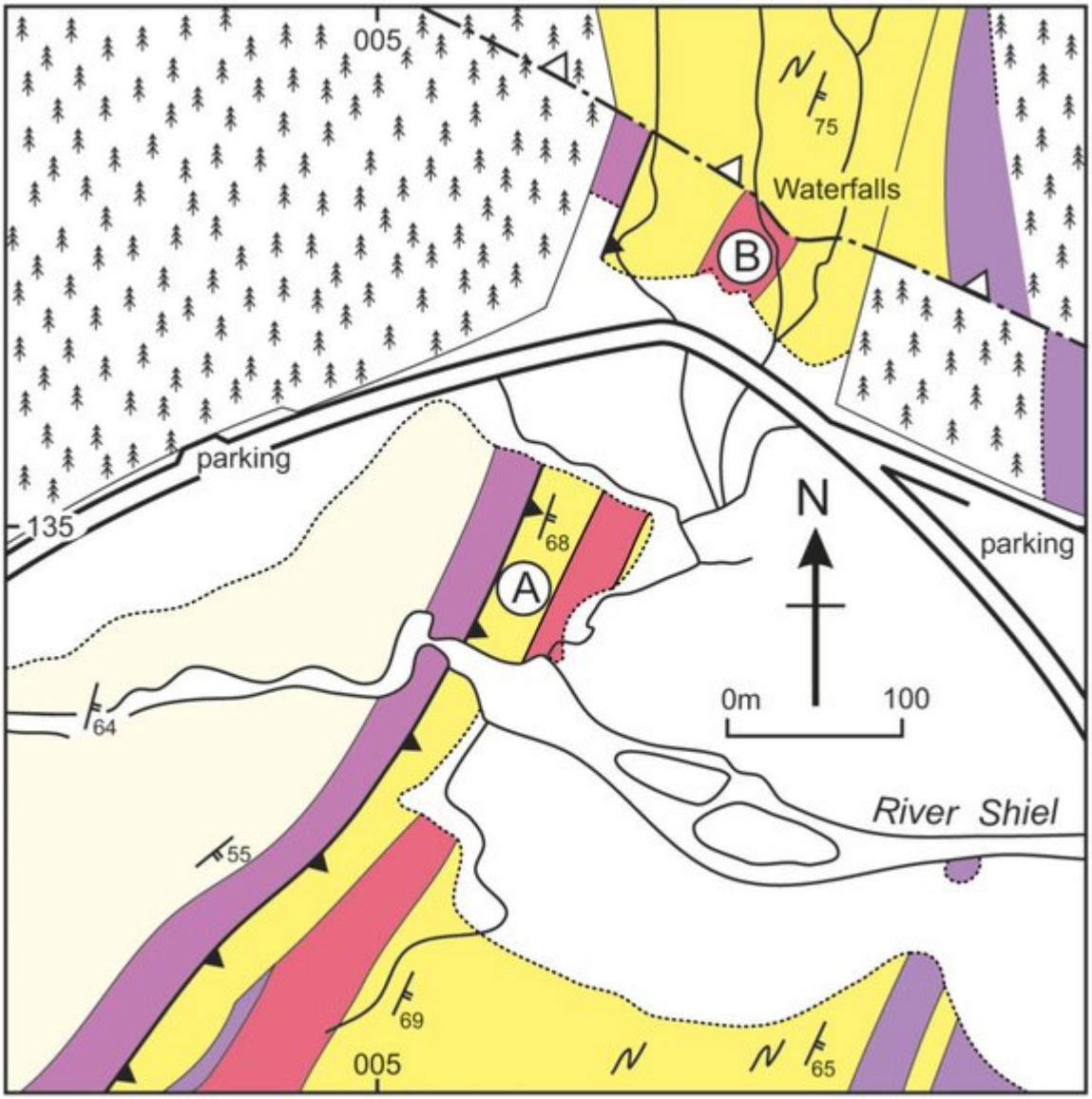
From the above observations it is apparent that the Lewisianoid hornblendic rocks do not lie immediately above the thrust. Detailed mapping has shown that the Lewisianoid rock types occur within an augen of low strain, perhaps within a fold core. The underlying limb of this fold has been cut out along the thrust. Cross back over the road to the gap between the forestry plantations. Looking up the hill, stop 6B is located within the lefthand stream beneath a small waterfall [NH 0082 1366].

Exposed in this stream section, 6B, are Lewisianoid hornblendic gneisses with associated bands of diopsidic marble. Above these occurs a zone of chloritic schists that lie beneath a late major low-angle fault. This thrust, exposed halfway up the waterfall, places vertically-oriented gneissose psammites over the Lewisianoid rock types. The fault zone consists of a series of anastomosing fractures between undeformed but rotated blocks of gneissose psammite. Within these fractures occurs a foliated microdiorite that was presumably intruded before the fault formed.

References



Map showing the regional geology, route and approximate locations of the localities.



Detailed sketch map of the Sgurr Beag Thrust zone at Locality 5.6. Refer to text for stops 5.6A and 5.6B. Dip and strike symbols refer to orientation of regional gneissosity.