

Grampian Highlands Field Guide: Day 6 - Mid Glen Lyon, Strath Fionan and Trinafour

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Day 6 - Mid Glen Lyon, Strath Fionan and Trinafour

Aims: to examine exposures of Easdale and Crinan Subgroup rocks; to view the nature of an ultramafic body and its contacts; to view the complex folding of the Ben Lawers Schist Formation, the Farragon Volcanic Formation and the Ben Lui Schist Formation in the Tummel Steep Belt; to examine parts of the folded Blair Atholl Subgroup (Appin Group) succession near Strath Fionan; to look at Lochaber Subgroup rocks and the 'Boundary Slide' by Trinafour.

Introduction

The Glen Lyon-Schiehallion area is certainly one of the most structurally complex parts of the Dalradian outcrop in the Grampian Highlands. This final day will first visit two localities in the middle part of Glen Lyon where the rocks belong to the Easdale and Crinan Subgroups (Argyll Group) and include the Carn Mairg Quartzite, Ben Eagach Schist, Ben Lawers Schist, Farragon Volcanic and Ben Lui formations. These varied lithological units show evidence of three or four phases of penetrative deformation, folding and cleavage formation. The related metamorphic events, which culminated in lower amphibolite facies conditions of about 8-10 kb (\approx c.27-33 km crustal depth) and 600°C, gave rise to growth of kyanite, garnet and staurolite porphyroblasts in the pelitic lithologies. The rocks lie within the Tummel Steep Belt and although bedding dips are variable the dominant S2 cleavage and subsidiary S4 cleavage are both generally steeply dipping (c.f. the 'Flat Belt'). As a result, the profiles of many of the folds and related interference structures can be mapped out, albeit obliquely. The Schiehallion-Glen Lyon area was mapped in detail between 1960 and 1994 by J E Treagus (University of Manchester), assisted by several PhD students, notably Philip Nell (1984) in Glen Lyon. This work subsequently led to publication of the 1:50 000 Schiehallion Sheet (55W) (British Geological Survey, 2000) and the attendant Memoir that described the solid geology (Treagus, 2000). Diagrams showing the bedrock geology (Figure 6.1) and the axial traces of the major folds (Figure 6.2) are taken from this last publication. Descriptions of the GCR sites in Glen Lyon and the Schiehallion area can be found in Treagus et al. (2013). It should be noted that publications covering the structure of this area have termed some of the fold phases with different notations. Hence, the D3 deformation phase of Treagus (2000) and earlier publications corresponds to D4 in the 'Flat Belt' and the Ben Lawers area in other publications (e.g. Treagus et al., 2013).

In the central part of Glen Lyon the structure is dominated by the large-scale D2 Ruskich Antiform, the lateral equivalent of the Ben Lui Fold (Treagus et al., 2013), which here is a relatively open upright structure whose axis plunges gently to moderately eastwards (c.30°) and whose axial plane dips steeply south. This antiform refolds two major recumbent D1 folds, the Chesthill Syncline and Meall Garbh Anticline such that these F1 folds locally face upwards (Treagus, 2000) (Figure 6.2). However, as the overall Argyll Group sequence is regionally inverted, the younger beds, i.e. the Ben Lui Schist Formation, crop out at structurally deeper levels higher up Glen Lyon. Farther east in the lower parts of Glen Lyon the D1 folds repeat the succession such that the Carn Mairg Quartzite, Ben Eagach Schist and Ben Lawers Schist formations form map-scale, fold-interference patterns

(Figure 6.1). These patterns are disrupted farther east by the NE-trending Loch Tay Fault. Note that on the southern flank of Glen Lyon the D4 Ben Lawers Synform and its related subsidiary folds dominate the structural pattern.

The orogenic significance of classic fold patterns in the Schiehallion area was first recognised by Bailey and McCallien (1937), but it is largely due to the later meticulous work of Treagus (1987, 2000) that we now also have a good understanding of their detailed geometry. Bailey and McCallien (1937) identified a number of ductile dislocations ('slides') within the folded succession, particularly linked to attenuation on major fold limbs. These 'slides' commonly related to apparent excision of parts of the stratigraphy and they culminated in a major generally southeasterly dipping dislocation, termed the 'Boundary Slide', which marked a major change in the stratigraphy and structure. Strongly folded Appin, Argyll and Southern Highland Group rocks were abundant to the south, structurally above the 'slide', whereas less deformed Grampian Group (formerly 'Younger Moine') rocks lay to the north, structurally below the 'slide'. However, Treagus (1987) recognised a full Appin and Argyll Group stratigraphy in much of the Schiehallion area, albeit strongly deformed and highly attenuated. He also showed that although the 'Boundary Slide' was basically a zone of very high strain (effectively a major ductile shear zone), a full stratigraphical sequence could be traced across it in places and thus continuity maintained (see Figure 6.2 and discussion below at the locality by Trinafour). This is similar to the Grampian-Appin Group boundary in the NE Grampians where the strain is less and such continuity is more easily demonstrated (see Day 4). However, much of the 'Boundary Slide' is unexposed on the western side of the Schiehallion embayment, and further west in the uppermost parts of Glen Lyon, Argyll Group formations are in contact with Lochaber Subgroup rocks (see Day 3). In these areas the 'slide' is the site of a considerable amount of missing stratigraphy (i.e. Appin Group + lower parts of Argyll Group) and thus has been interpreted as marking an unconformity. It appears to mark a structural high with sedimentary onlap of the younger Dalradian formations on its southern side. Certainly, in parts it has subsequently been the site of ductile, north to northwest vergent, shear-related deformation, but this late tectonic identity probably reflects the earlier structural and sedimentary templates.

In addition to the multitude of mafic intrusions in the Argyll Group succession, both here and elsewhere in the Grampian Highlands, ultramafic bodies are also present. They are concentrated within rocks of the Easdale and Crinan Subgroups, even extending into Ireland. Chew (2001) interpreted them as marking an early phase of crustal rifting causing local rupture and exposure of the ocean-continent boundary. This would tie in with the occurrence of the Foss baryte deposit, a stratiform mineralized horizon up to 80 m thick (with up to 15 m baryte), hosted by the Ben Eagach Schist Formation (Easdale Subgroup) and best developed on Ben Eagagach. This barytes-celsian-sulphide (dominantly pyrite and sphalerite) deposit is interpreted as of sedimentary exhalative (SEdEx-type) origin, formed on the sea floor of a small oceanic basin, testifying to periods of significant crustal extension possibly linked to local exhumation of mantle diapirs.

Two such examples of ultramafic bodies have been mapped on the Roro Estate, on the southern flank of Glen Lyon, one on Dubh Cnocan [NN 617 471], which is patently folded, and a larger Z-shaped lenticular body on the col just to the south, centred around [NN 615 465] (Figure 6.5). Their presence and relationships to the adjacent dominantly metasedimentary succession have repercussions for the geological history of the Dalradian Supergroup.

Localities

Balnahanaid, Roro Estate, Glen Lyon [NN 617 467]

Having negotiated your way from Kindrogan to Aberfeldy, Weem and Fortingall take the narrow single-track minor road that weaves through the lower gorge-like parts of Glen Lyon. Once past Inverar you emerge into a wider part of the glen with the flat-floored valley framed by steep flanks

and imposing summits on both its northern (Carn Mairg, Carn Gorm) and southern (Meall Garbh, Ben Lawers) sides (Figures 6.3, 6.4). At Camusvrachan [NN 6200 4784] turn left onto a good track and park just before bridge over River Lyon. Walk to T-junction, turn left along a very good gravel track to Balnahanaid Farm [NN 6333 4718]. Just beyond the farm traverse up the hill along a grassy cart track that gives access to sheep pastures around the watershed. The first outcrops occur in the small burn and then by the track and beyond. In total the distance is c.2.3 km and height difference c.100 m. Note that the detailed bedrock geology is shown on Figure 6.5, abstracted from the hand-coloured version of the 1:10 000 clean copy NN 64 NW.

In the small burn that runs just below the track steeply SSE-dipping, thinly bedded muscovitic semipelite and psammite crop out at intervals. These belong to the Ben Lui Schist Formation although the 'trademark' garnets are only rarely seen here. However, just by the gate at [NN 6199 4678] a more uniform dark grey to grey green rock is exposed. This is a serpentinitised ultramafic rock containing much amphibole, mapped by Nell (1984) as a picrite. It is relatively massive but does rarely show sparse evidence of significant mineralogical banding. The lenticular body is mapped as terminating just to the northeast. A short distance further west the contact of the ultramafic body and the metasedimentary rocks is exposed, first in the burn, and then by the track where semipelite is interleaved with marginal ultramafic sheets (altered largely to actinolite and talc?). At [NN 6176 4670], again just by the track, a strongly deformed lenticular bed of pebbly psammite dips steeply south. It shows possible grading and a strong extension lineation that plunges 50° to 131°. The ultramafic body, which is at least 30 m thick, shows some variations in its composition, alteration, and fabric development, but even in the thicker parts obvious evidence of igneous banding is difficult to find. Note that Nell (1984) recorded relict igneous layering dipping moderately to steeply south in its central part. On the western side of the small knoll on the ridge at [NN 6138 4649] a deformed felsic vein (locally pegmatitic) with lenticular ultramafic inclusions occurs in a foliated more mafic host (Figure 6.6). Return to Balnahanaid and Camusvrachan from the col.

Slatich – Ruskich area (Creag Mhór) [NN 6407 4775]

Retrace your route a short distance back down Glen Lyon. Some 2 km along the road just past Slatich a gate leads onto the unfenced hill ground. If your party is large it is best to disembark most people here and then park at least one vehicle some 550 m further on by gate into the field on the left (limited space at roadside). Alternatively, ask at Slatich for permission to park by the farm property. The aim is to traverse northeast around base of Creag Mhór and then walk eastwards to find the wooden steps over the imposing wall and descend to the parked vehicle. In total c.1.2 to 2 km over mixed terrain – grass, bracken, some gorse, rocks, etc. with a height difference of c.60 m.

The section to be traversed lies on the northern flank of the Ruskich Synform and exposes strongly folded rocks of the Ben Lui Schist, Farragon Volcanic and Ben Lawers Schist formations. The major and minor F2 folds plunge moderately eastwards, but the stratigraphical sequence is inverted, hence giving map pattern shown in Figures 6.5 and 6.7. The locality is described in Treagus et al. (2013-GCR locality 20). The oldest unit is the Ben Lawers Schist Formation, which here consists of interbedded calcareous semipelite and psammite with subsidiary impure metalimestones and calc-silicate lenses. In the field its normally dominant calcareous nature is not always readily apparent in outcrop, but is manifest by the grassy pasture areas on the lower relief spur east of Creag Mhór. The uppermost parts of the Ben Lawers Schist Formation are mapped as dolomitic quartzites but again the field exposures suggest there is a gradational change, emphasising a relatively subsidiary component. Psammite and quartzite interbeds and calc-silicate lenses are certainly present, giving rise locally to excellent small-scale fold interference patterns (F2 + F4) (Figure 6.8), but the lithology exposed does not differ that markedly from the Ben Lui Schist Formation that lies

structurally below to the west. The Farragon Volcanic Formation separates the two formations, its distinctive lithology has not only been responsible for the generation of a complex structural pattern but also has allowed its elucidation. Treagus (2000) noted that it consists of a variable set of lithologies including coarse and fine-grained amphibolite, garnetiferous pelite and semipelite, psammite and quartzite (locally gritty and even pebbly). Calcareous and graphitic lithologies are absent here (but see Day 3). The formation reaches 100–150 m thick east of the Loch Tay Fault, but in Glen Lyon it is thinner (c.80 m at maximum) (Treagus, 2000). The distinctive feature of the formation is the finely interbedded nature of the amphibolite and the metasedimentary lithologies. This occurs on scales ranging from tens of metres to tens of centimetres and even millimetre-scale lamination and may be sharp or gradational. The coarser-grained and generally thicker bodies with schistose margins are interpreted as intrusive sheets whereas the finer bedded units are interpreted as volcanic or volcanoclastic in origin. In parts the delicate amphibolite-psammite/quartzite lamination defines tight to isoclinal folds. Both F1 and F2 folding have been recorded, including rare F1+F2 fold interference patterns, e.g. Treagus et al., 2013 (Figure 6.9). The lithology also shows a well-developed hornblende lineation in the Creag Mhór area. Note that the mapped outcrop pattern shows that the Farragon Volcanic Formation is somewhat lenticular and that other minor metavolcanic units have been mapped in the overlying Ben Lui Schist Formation. This pattern may reflect the initial lenticular stratigraphical template or result from boudinage, attenuation and/or dislocation during the D1, D2 and D4 deformation episodes.

Our traverse takes us through this complex folded zone and gives us an opportunity to view the unusual nature of the Farragon Volcanic Formation, its relationship to the adjacent Ben Lawers and Ben Lui formations, and to try to find some convincing examples of small-scale F1 folds — a rare occurrence in this part of the Dalradian succession.

Knoll above Loch an Dàim [NN 7161 5734] (Strath Fionan)

Follow the road back down Glen Lyon, and past Fortingall to the Coshieville Hotel where you turn left up onto the B846 towards Tummel Bridge. After some 6 km take the minor road left towards Strath Fionan and Kinloch Rannoch. Pass by the classic mapping area as mapped on SXR339 (exposure is not the best — wave nostalgically). After c.8 km park opposite the old metalimestone quarry c.250 m beyond Lochan an Dàim at [NN 7150 5742]. From here it is only a short walk to disused quarries opposite and the excellent exposures above — total distance c.250 m and a height difference of c.30 m.

Strath Fionan is renowned for its outcrops that when taken together provide a continuous stratigraphical section from the upper part of Grampian Group through the Lochaber and Ballachulish subgroups (Appin Group) and up to the Schiehallion Boulder Bed (basal Islay Subgroup). Treagus et al. (2013-GCR locality 17) recognised a folded and attenuated succession, notably of Appin Group rocks, which they argued could be correlated with type sections in the Loch Leven area and elsewhere. Despite the patchy exposure the varied but distinctive lithological nature of many of these units, e.g. the Beoil Quartzite, the Meall Dubh Limestone, Graphitic Schist and Quartzite formations, the Blair Atholl Dark Limestone and Schist Formation, makes them readily mappable, such that the structural pattern can be deciphered (Figure 6.10). Although deformation is high in the area, particularly as the Appin- Grampian Group boundary is approached, in parts sedimentary structures can still be recognised, enabling younging and facing to be determined. On the southwestern flank of Strath Fionan the Blair Atholl Subgroup rocks are repeated about a major antiformal core, within which the Schiehallion Boulder Bed Formation is exposed. This is the F2 Ballimore Antiform, a gently to moderately S- to SE-plunging structure that folds the inverted succession. It is one of a series of major F2 folds that affect the whole Dalradian succession in this area (Figure 6.2). Earlier F1 major folds (downward facing here) are refolded by the F2 structures. Indeed, Treagus (2000) reported that metalimestones of the Blair Atholl Limestone Formation are

repeated by large-scale F1 folds around Lochan an Dàim and that examples of isoclinal F1 minor folds refolded by tight F2 folds can be seen by the roadside at [NN 7166 5736]. Note that the F1 and F2 major folds are themselves refolded by the tight Errochty Synform and the broader more open Bohespic Antiform, whose axial traces trends NNE at a high angle to the F2 structures (Figure 6.2). This combination of folds, the high strain associated with the 'Boundary Slide', and the original stratigraphical template, have all been responsible for the resultant regionally indented, complex outcrop pattern, informally termed the 'Schiehallion twist' (Figure 6.1).

At this locality ascend past the disused quarries (note minor folding) onto the small rocky knoll overlooking the lochan to view a gentle SE-plunging F2 fold hinge developed in the lower metalimestone of the Blair Atholl Dark Limestone and Schist Formation (Figure 6.11). This broad hinge, some tens of metres wide, forms part of a subsidiary F2 fold on the northern limb of the Bailliemore Antiform, and is very well exposed in the clean karstic surface on the top of the knoll. Graphitic pelite and cherty interbeds, and in places stylolites, define the bedding very well, but S2 cleavage is only rarely seen. Note that F1 folds are difficult to find.

By Trinafour [NN 7255 6560]

From Loch an Dàim follow the minor road westwards to Kinloch Rannoch where you turn right (east) in the village onto the B846. After some 4 km take the B847 northwards to Trinafour [NN 728 646]. Note that your sinuous route zig-zags northwards mostly within the outcrop of folded Appin and Argyll Group rocks that lie within the Errochty Synform ('Schiehallion twist'). At Trinafour turn left onto the minor road leading north to Dalnacardoch and drive up past the hairpin bends (now improved) to park by a track near the crest of the hill at [NN 7255 6560]. The relevant outcrops are by the roadside.

As noted above, the 'Boundary Slide' and tightly folded Dalradian succession have been refolded by two later SSW-plunging folds, the tight Errochty Synform and the more open Bohespic Antiform. Both of these fold structures are tighter in the Grampian Group rocks at deeper crustal levels in the north and become more open southwards. Treagus (1987) reported that the Errochty Synform plunges some 25°SSE near Loch Errochty, but this reduces to 11°S farther south at Creag an Fhithich [NN 668 572]. In contrast the Bohespic Antiform plunges fairly consistently at c.55°S but has a poorly defined axial surface. Treagus (1987) pointed out that the folds have an asymmetrical profile that is repeated farther west in the Loch Rannoch area. He attributed this geometry to the presence of the thick but lenticular Schiehallion Quartzite (Islay Subgroup), here repeated by tight F1 and F2 folds in the wide hinge area and western limb of the Bohespic Antiform but thin or absent elsewhere. Minor open folds and related crenulation cleavages are generally confined to the hinge zones of the two folds, but are also seen on their common steep limb. The Errochty Synform is itself folded by two later structures, the Trinafour Antiform (Monoform) and the Croftnagowan Synform that plunge to the SSE. Minor chevron folds and fracture zones are related to these late-stage structures, which are in turn cut by the prominent NNE-trending faults.

The traces of the F1 and F2 major folds and their related cleavages thus describe a complex hook-shaped pattern with their original orientations strongly modified by the two phases of later refolding. This pattern is focussed around the Grampian-Appin Group boundary; its effects become more muted at both lower and higher structural levels. Note that the D4 folds developed farther south (e.g. the Ben Lawers Synform), which have ENE-trending axial traces and a related S4 crenulation cleavage, die out north of Glen Lyon (and by Loch Tummel east of the Loch Tay Fault) and are not found in the Schiehallion area or farther north. Treagus (1987) considered the relationships between the D4 structures and the Errochty-Bohespic folds, favouring a later age for the latter set, but subsequently reversed this judgement (Treagus, 2000), although admitting that the evidence was equivocal. Note that Treagus (2000) also recognised several other minor fold phases in the Schiehallion area. However, these are areally limited and merely complicate the local

structural history a little further, but have little or no impact on the overall structural picture.

Above Trinafour around [NN 7255 6560] we are situated on the eastern limb of the Errochty Synform where the 'Boundary Slide' is represented by a highly attenuated sequence of Lochaber and Appin Subgroup rocks (Figures 6.1, 6.2). Treagus (2000) identified numerous formations but stated that many are difficult to recognise, having been reduced to only a few metres in thickness. The Tummel Psammite Formation (upper Grampian Group) passes transitionally westwards into a sequence of semipelitic, quartzitic and pelitic rocks that Treagus (2000) identified as the Dunalistair Semipelite, Beoil Quartzite, Beoil Schist, and Meall Dubh Graphitic Schist formations. A dolomitic metalimestone allocated to the Strath Fionan Limestone formation is then succeeded by graphitic pelites and metalimestones of the Blair Atholl Subgroup. Amphibolitic mafic sheets are common within this attenuated sequence but are concentrated in the Schiehallion Quartzite Formation that here occupies the core of the Errochty Synform (exposed around Errochty Dam). Note that as mapped the normally persistent Dunalistair Quartzite Formation (basal Lochaber Subgroup) is missing, as is the Meall Dubh Quartzite Formation. The Beoil Schist Formation is a mica-rich pelite with abundant thin quartz veins and pods; its high muscovite content made it a candidate for possible commercial exploitation for industrial mica but its limited occurrence, biotite content (10-20%), and high iron content militated against development. Note the 'tramline' nature of the attenuated bedding that here dips very steeply eastwards, the dominant S2 fabric and the deformed quartz veins. F2 minor folds plunge gently to moderately SE. The difficulty of correlating the exposed lithologies with relatively undeformed equivalent units elsewhere should be apparent.

On reversing your route to Trinafour stop briefly at the roadside by the new road cut made to allow access for heavy vehicles for construction of the Beaully-Denny transmission line. The newly excavated cut provides an informative cross-section through similarly attenuated Lochaber Subgroup lithologies.

From Trinafour return along B847 eastwards to Calvine where you join the A9. Return southwards to Pitlochry and thence to Kindrogan.

[File:GHFGfig6.1.jpg](#)

Figure 6.1 Generalised map of the Bedrock Geology of the Schiehallion district (Sheet 55W) (from Treagus, 2000). Note that the figure boxes refer to areas covered by more detailed diagrams in the memoir.

[File:GHFGfig6.2.jpg](#)

Figure 6.2 Diagram showing the location of the axial traces of the principal folds in the Schiehallion district (Sheet 55W) and their relative ages, where known. Note that the D3 traces are now regarded as D4. The traces labelled

DL, Dt and De refer to Lyon, Trinafour and Errochy phases, all of which have significant local expression in this area, but their relative ages of development are unclear. (from Treagus, 2000).

[File:GHFGfig6.3.jpg](#)

Figure 6.3 View southwest from [NN 6410 4761], east of Slatich, to the Roro Estate and Creagan Eildeag, mid Glen Lyon. The darker, more massive outcrops above Roromore House are composed of metamorphosed ultramafic rocks, surrounded by the Ben Lui Schist Formation.

[File:GHFGfig6.4.jpg](#)

Figure 6.4 View northeast from [NN 6192 4678] down Glen Lyon towards Slatich and Carn Mairg (1042 m) from the Roro ultramafic body, whose northwestern contact with steeply dipping semipelites and psammities of the Ben Lui Schist Formation can be seen in the foreground.

[File:GHFGfig6.5a.jpg](#)

Figure 6.5a Extract from 1:10 000 clean copy NN64NW, mapped by P A R Nell 1979-1981 (BGS, 1997).

[File:GHFGfig6.5a.jpg](#)

Figure 6.5a Key to the lithostratigraphy of the Dalradian Supergroup rocks, Intrusive Igneous rocks and structural symbols as shown on 1:10 000 clean copy NN 64 NW (BGS, 1997).

[File:GHFGfig6.6.jpg](#)

Figure 6.6 Felsic veining with included lenticular ultramafic lenses in a more foliated and deformed part the Roro.

[File:GHFGfig6.7.jpg](#)

Figure 6.7 Map of the complex hinge zone of the Ruskich Antiform, east of Slatich, Glen Lyon (Treagus et al., 2013).

[File:GHFGfig6.8.jpg](#)

Figure 6.8 Fold interference pattern (F2 + F4?) in semipelite (partly calcareous), psammite, and calc-silicate rock of the Ben Lawers Schist Formation. Calc-silicate lenses and layers are relatively competent and commonly form the locus for folding. Glaciated rocky tump east of Slatich below Creag Mhor [NN 6412 4762].

[File:GHFGfig6.9.jpg](#)

Figure 6.9 Cut surface in finely interbedded amphibolite and quartzite of the Farragon Volcanic Formation showing isoclinal F1 folds (hinges arrowed) refolded by tight F2 folds. About 800 m ENE of Slatich at [NN 6407 4778] (Photo: J E Treagus, Treagus et al, 2013). Scale bar in centimetres.

[File:GHFGfig6.10.jpg](#)

Figure 6.10 Geological map of Strath Fionan (from Treagus et al., 2013).

[File:GHFGfig6.11.jpg](#)

Figure 6.11 Karstic weathering in the lower metalimestone of the Blair Atholl Limestone and Dark

Schist Formation in the
hinge zone of an F2 fold.

Above Loch an Daim

[NN 7161 5734].

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