
17 Strath Fionan

[NN 720 580]–[NN 745 560]

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17.1 Introduction

This GCR site is located on the slopes of Strath Fionan, immediately adjacent to the minor road which runs around the north side of the isolated mountain, Schiehallion (Figure 3.41). It provides the only continuous section in the Central Grampian Highlands, from the top of the Grampian Group through the Lochaber and Ballachulish subgroups of the Appin Group (Table 1). Each of the formations has observable sedimentary boundaries with its neighbours and sedimentary structures can be used to establish the continuity and the way up of the succession. Additional attractions include minor folds, a great variety of metamorphic minerals and microdiorite dykes and the area is popular for student field parties and mapping projects.

The uniformly south-dipping sequence was originally interpreted by Bailey and McCallien (1937) as the folded and faulted repetition of the Blair Atholl ‘Series’ (now the Blair Atholl Subgroup) and of the Schiehallion Quartzite and Killiecrankie Schist, which occur to the south of the GCR site. The junction at the base of the Blair Atholl ‘Series’ with the ‘Moines’ (now the Grampian Group) was interpreted as a major synmetamorphic dislocation, since the interpretation required considerable excision of the stratigraphical succession. This tectonic junction, named the Boundary Slide, the equivalent of the Itay Boundary Slide in the south-west Grampian Highlands (MacGregor, 1948; Rast, 1963), plays a major role in Dalradian tectonics. This interpretation was supported subsequently by Rast (1958), who interpreted a persistent outcrop of schist immediately above the slide, the Beoil Schist, not as a stratigraphical formation but as a product of localized ductile deformation.

The present interpretation is that of Treagus and King (1978) and Treagus (1987) who maintained that the sequence may be directly correlated with the type Appin Group sequence *below* the Blair Atholl Subgroup and that it is a continuous south-younging sequence, uninterrupted by major folds or dislocations. The zone of Appin Group formations, including the Beoil Schist, immediately above the Grampian Group, although the locus of high strain, was not considered to contain a major dislocation.

The geometry of the dominant set of minor folds, seen in most of the lithologies, shows that the succession lies on the short, overturned limb of a fold (the Balliemore Antiform of Bailey and McCallien, 1937), which is one of the major F2 folds in the region according to Treagus (1987). The stratigraphy and structure of the Strath Fionan area has been described more fully in the Geological Survey memoir for Sheet 55W (Treagus, 2000).

17.2 Description

The principal lithologies of the GCR site may be conveniently examined in transects A–A’, B–B’ and C–C’ (Figure 3.41).

17.2.1 Lochaber Subgroup

Good exposures of the uppermost Grampian Group and of the lowest four formations of the Appin Group can be seen on or close to the line of transect A–A’ [NN 723 577]–[NN 721 576]. The transect provides the type section for the lowest two formations of the Lochaber Subgroup, the Dunalastair Quartzite and Dunalastair Semipelite.

The Grampian Group psammities (the Kynachan Psammite Formation of the Glen Spean Subgroup) are in sharp contact with the Dunalastair Quartzite and exhibit clear south-younging cross-beds a few metres from the boundary; there is no evidence of unusually high strain or of structural discordance at the contact. The typically rather pink-weathering quartzites and quartzose psammities of the Dunalastair Quartzite, in well-bedded 100–300 mm-thick units, exhibit slight variations in feldspar content, but are rarely as feldspathic as the adjacent Grampian Group psammities. Cross-bedding is evident from feldspar and heavy mineral concentrations, and truncated foresets may be observed within a few metres of the Grampian Group, confirming the age relationships.

Good exposures of the Dunalastair Semipelite within the area of (Figure 3.41) can be seen along the ridge crossed by the transect A–A', on Speirean Ruadh [NN 735 570] and south-west of Lochan Beoil. Although the dominant lithology in this formation is a biotite-muscovite-garnet semipelite, its characteristic feature is a ribbed appearance on a variety of scales, owing to the presence of psammitic laminae, which are dominant close to the lower boundary. Cross-bedding is apparent in the thicker psammities, which are similar in character to those of the Grampian Group; no way up has been determined near the line of transect but evidence of the southward younging has been found near Lochan Beoil.

The Beoil Quartzite and Beoil Schist are well exposed to the south-west of the above formations in transect A–A', but the type section of these formations occurs to the north of transect B–B', on the steep south-facing scarp west of Lochan Beoil. Generally within the area of (Figure 3.41), the BEOIL Quartzite can be traced as discontinuous 100–300 mm-thick ribs of pure white quartzite separated by layers of semipelite 10–500 mm thick. Thin beds (100–300 mm) of pelite of Beoil Schist aspect and of quartz-feldspar psammities similar to those in the Dunalastair Semipelite also occur within the formation. The ribs of quartzite are commonly seen to be affected by tight folds with wavelengths of several metres (F1 and F2 of (Figure 3.42), see Interpretation below) and it is clear that this results in considerable duplication. No certain sedimentary structures have been detected in these strongly deformed rocks. The Beoil Schist is well exposed within the area of (Figure 3.41), forming a prominent topographical feature. The schist is characterized by an unusual concentration of muscovite and the presence of pods of vein quartz. The stratigraphically lower half, apart from these characteristics, is very similar to the Dunalastair Semipelite described above. It is a biotite-muscovite-garnet pelite or semipelite with thin ribs of quartzofeldspathic psammite and some quartzite ribs towards the lower, well-exposed, gradational boundary. The upper half has striking muscovite-rich schistosity surfaces studded with 1–8 mm garnets and streaked with quartz veins and pods; it is noticeably less biotitic than the lower part and bedding is not as obvious. No certain sedimentary structures have been detected in these strongly deformed rocks. Boudins of garnetiferous amphibolite are present.

A pronounced topographical hollow separates the Beoil Schist from exposures of the Meall Dubh Striped Pelite and the junction is nowhere well exposed. It is best seen north of the transect B–B' in an area where the stratigraphy is repeated by several F2 isoclinal folds. The type section of the Meall Dubh Striped Pelite Formation is at the northern end of transect B–B', in a 20 m-long ridge at [NN 7386 5661]. Here, the delicately striped alternations of fine-grained psammite and schistose muscovite-biotite pelite are well displayed in a 5 m-wide section. Garnet and feldspar porphyroblasts seen here are characteristic of this lithology, as is grading in the 10–30 mm stripes of fine-grained psammite. Although the junction with the Meall Dubh Limestone is not well displayed, the youngest beds in this section are calcareous; carbonate-rich rocks are seen a few metres to the south, suggesting a transitional boundary. This junction marks the Boundary Slide of Bailey and McCallien (1937).

17.2.2 Ballachulish Subgroup

The exposures along the line of traverse B–B' [NN 7386 5661]–[NN 7432 5630] give the opportunity to examine the constituent formations of the Ballachulish Subgroup in reasonable proximity, although some of the type sections detailed below occur elsewhere in Strath Fionan.

Yellow-weathering, 'grey-hearted' carbonate rock, calcareous schist and tremolitic amphibole schist are all represented in the thin, poorly exposed, Meall Dubh Limestone Formation. Biotite or phlogopite porphyroblasts are usually conspicuous in the latter two lithologies; colourless tremolite and green actinolite occur locally as rosettes. No sedimentary structures have been observed.

The Meall Dubh Graphitic Schist Formation is particularly well displayed on the ridge to the east and west of the line of transect B–B'. The type section is a prominent crag at [NN 7409 5645], where the graphitic schist displays 30–100 mm crystals of kyanite (black, as a result of graphite inclusions) as well as common biotite and garnet and rarer staurolite and feldspar porphyroblasts. Bedding is seen as non-graphitic semipelite ribs at 100–200 mm intervals. Concordant garnetiferous amphibolites are a feature of this formation. The boundary with the Meall Dubh Limestone is not well exposed, although isolated occurrences with admixtures of graphitic schist and calcareous schist show that it is gradational. The upper boundary is seen along strike to the east at [NN 7422 5640], on the north side of the ridge of Meall Dubh Quartzite. Here graphitic kyanite-bearing semipelite and pelite merge into a metre of transitional muscovitic, rusty quartzite containing graphitic seams. At the eastern edge of the quartzite outcrop on Meall Dubh [NN 727 567], 2–3 m of a very characteristic transitional facies of the graphitic schist is developed. This consists of finely bedded, fine-grained quartzite with black graphitic laminae, which exhibits cross-lamination in some exposures. Some of the 20 mm-thick semipelitic beds exhibit grading of their graphite content. The younging is consistently towards the overlying quartzite, allowing for the presence of major and minor folds that affect this boundary.

On transect B–B' the upper 20 m of the Meall Dubh Quartzite Formation may be examined on the south bank of the Allt Strath Fionan at [NN 7424 5634], where 200–500 mm-thick beds display a characteristic strong pebble lineation and feldspar-rich and heavy mineral laminae. Cross-bedding in 100 mm beds youngs south towards the Strath Fionan Banded Semipelite, some 20 metres distant. The junction between the two formations is not exposed here, but may be identified farther east on the south bank at [NN 7432 5631]; exposure is poor but there appears to be no transition. The exposures on Meall Dubh [NN 729 567], where the outcrop is greatly thickened by folding, provide many clean sections where the detailed mineralogy, deformation and sedimentary structures of the formation can be seen.

The Meall Dubh Quartzite typically comprises 70–80% coarse-textured quartz; the remainder consists of pink and milky-white feldspar occurring as 2–10 mm-long rod-shaped clastic grains, commonly concentrated in thin (50 mm) beds. Plate-like aggregates of quartz grains (up to 30 mm in maximum dimension and 5 mm thick) appear to represent highly deformed original clasts and indicate that the original rock was partly conglomeratic. Cross-bedding on the ridge above the roadside at [NN 7275 5654] and to the east, youngs south towards exposures of the Strath Fionan Banded Semipelite.

Table 3.1 Summary of the Dalradian sequence in the Schiehallion district.

Group	Subgroup	Formation	Metasedimentary rocks	Igneous rocks
Southern Highland		Pitlochry Schist Fm with <i>Green Beds</i>	gritty semipelite/psammite gritty hornblende schist	basic volcanism - sills+ volcaniclastic rocks
Argyll	Tayvallich	Loch Tay Limestone Fm	limestone and calc-schist	
	Crinan	Ben Lui Schist Fm	garnet semipelite/psammite	
	Easdale	Farragon Volcanic Fm	amphibolite and semipelite	basic volcanism - sills+ volcaniclastic rocks
		Ben Lawers Schist Fm	calc-semipelite/amphibolite graphitic	
		Ben Eagach Schist Fm	pelite/semipelite, Ba-Zn deposit near top	
		Cam Mairg Quartzite Fm	pebbly quartzite	
		Killiecrankie Schist Fm	semipelite/psammite	volcaniclastic rocks
	Islay	Schiehallion Quartzite Fm	fine-grained quartzite	
		Tempar Dolomitic Member	calc-pelite/semipelite and dolomitic limestone	

Appin	Blair Atholl	Schiehallion Boulder Bed	diamictite with stones of granite, quartzite and limestone in calc-semipelite matrix
		Drumchastle Pale Limestone Fm	tremolitic/dolomitic limestone
		Cnoc an Fhithich Banded Semipelite Fm	semipelite/psammite
		Blair Atholl Dark Limestone & Schist Fm	limestone/graphitic pelite
	Ballachulish	Tullochroisk Semipelite Fm	banded semipelite/psammite
		Strath Fionan Pale Limestone Fm	tremolitic/dolomitic limestone
		Strath Fionan Banded Semipelite Fm	pelite/semipelite/psammite
		Meall Dubh Quartzite Fm	pebbly feldspathic quartzite
		Meall Dubh Graphitic Schist Fm	graphitic pelite
		Meall Dubh Limestone Fm	tremolite schist/dol. limestone
		Meall Dubh Striped Petite Fm	calc-schist and semipelite
		Beoil Schist Fm	muscovite-garnet pelite
	Lochaber	Beoil Quartzite Fm	thin quartzite
		Dunalastair Semipelite Fm	ribbed semipelite/psammite
		Dunalastair Quartzite Fm	quartzite/quartz psammite
Grampian	'Strath-tummel' ^a	Kynachan Psammite Fm	thick-bedded psammite
		Kynachan Quartzite Fm	feldspathic quartzite
		Tummel Psammite Fm	thick-bedded psammite
		Tummel Quartzite Fm	quartzite/schistose psammite
	'Atholl' ^a	Bruar Psammite Fm	flaggy psammite/semipelite

Adapted from Treagus (2000).

^a The Atholl and Strath-tummel subgroups of Treagus (2000) are no longer recognized; the strata are now regarded as part of the Glen Spean Subgroup.

Exposures of the Strath Fionan Banded Semipelite Formation in the Allt Strath Fionan (transect B–B', [NN 7424 5634]–[NN 7432 5631]) are typical of the usual, rather friable, slightly rusty-weathering, muscovitic, interbedded pelite and semipelite in this formation. Four metres of schistose metacarbonate rock mark the transitional junction of the pelite with the succeeding metalimestone in the steep south bank of the burn. These exposures comprise the type section. Typical lithologies can also be seen along the roadside to the west, as far as the junction with quartzite described above at [NN 7275 5656]. Bedding is usually a prominent feature on a 10–100 mm scale and broken or cut specimens reveal a wealth of sedimentary structures, in particular channelled cross-laminations and small-scale grading. Sedimentary structures consistently indicate younging to the south. Biotite, but not garnet, is usually evident.

The southern end of transect B–B' provides an almost continuous section from the Strath Fionan Banded Semipelite Formation, through the Strath Fionan Pale Limestone Formation into the Tullochroisk Semipelite Formation. However, the quality of the exposure is poor and the latter two formations are better seen at the northern end of transect C–C'. This transect [NN 7137 5675]–[NN 7186 5658] also permits the examination of all the remaining formations of the Appin Group.

The type section for the Strath Fionan Pale Limestone Formation is at prominent crags south of the road at [NN 7275 5638]. Although the base of the formation is not seen here, the crags expose 20 m of white, almost pure, dolomite-tremolite rock. Bedding can usually be detected as 2–3 mm-spaced slightly quartzose laminae; other beds are conspicuously muscovite rich and phlogopite is a minor constituent. The lower beds (to the east) are noticeably more tremolite rich, some exhibiting rosettes 100 mm across. At the west end of this locality the sharp junction with the overlying Tullochroisk Semipelite is seen. Similar rocks occur at the start of transect C–C' on the north bank of the burn [NN 7237 5675], although here the rocks are more pelitic.

The Tullochroisk Semipelite Formation is well exposed in the burn draining Lochan an Daim, and its sharp lower boundary is well seen in exposures above the type locality of the Pale Limestone at [NN 7275 5638]. However, the formation is best seen on or near the line of transect C–C', (Figure 3.41). A burn section to the south of the transect [NN 7235 5662]–[NN 7223 5663], where the outcrop is considerably thickened by F2 folding, is the type section of the lower half of the formation. Here the dominant lithology is a rusty-weathering semipelite with psammitic beds, not unlike the Strath Fionan Banded Semipelite, although the Tullochroisk Semipelite contains a greater proportion of fine-grained psammite than the older formation. It is generally a non-graphitic, but pyritic, muscovite-biotite schist, with fine-grained psammite laminae 1–5 mm thick and quartzose psammite ribs 100–200 mm thick. Small-scale cross-laminations and graded bedding have been observed younging south near the boundary with the underlying Strath Fionan Pale Limestone.

The upper half of the formation has its type section on the line of transect C–C', where the upper junction is well seen. Lithologies in the upper half of the formation are distinctly more-graphitic than those typical of the lower half, and locally they are as graphitic as the pelites of the overlying Blair Atholl Dark Limestone and Dark Schist Formation. They commonly contain small garnet, staurolite and kyanite crystals, but are characterized by large (c. 5 mm) biotite porphyroblasts. Fine-grained psammitic laminations (2–3 mm) and ribs of coarser grained psammite (100–200 mm), with rare small-scale grading, are usually evident. This change of character defining the upper part of the formation is marked by a gully between [NN 7226 5656] and [NN 7220 5663], and by a grey metalimestone (maximum thickness 8 m) to the east, between [NN 7235 5646] and [NN 7278 5636]. The junction with the first grey metalimestone of the Blair Atholl Dark Limestone and Dark Schist Formation, marking the start of the Blair Atholl Subgroup, is seen on, and to the north-west of, the line of transect at [NN 7186 5660], followed by excellent exposures of the complete Blair Atholl Subgroup (Figure 3.41). It is also especially well seen to the west and south of Lochan an Daimh (Figure 3.43).

Immediately to the south of transect C–C', there is a very clear repetition of the formations of the Blair Atholl Subgroup about a major antiformal core, enclosing the Schiehallion Boulder Bed of the Islay Subgroup. This is the Ballimore Antiform of Bailey and McCallien (1937), a major fold of F2 age according to Treagus (1987). Minor folds, sympathetic to this major closure, verging to the south, plunging to the east and associated with an intensely developed crenulation cleavage, can be observed in most of the lithologies described above.

17.3 Interpretation

The sequence exposed in Strath Fionan is a continuous stratigraphical succession from the uppermost formation of the Grampian Group through the Lochaber and Ballachulish subgroups of the Appin Group. The boundaries between formations are usually transitional and sedimentary structures show consistent upward younging; there is no evidence for major repetition by folding nor of dislocation. However, the formations of the lower part of the Appin Group, from the Dunalastair Semipelite through to the Meall Dubh Striped Pelite do show, from the intensity of folding and of schistosity and the absence of sedimentary structures, that these rocks have suffered high strain. This interpretation (Treagus and King, 1978; Treagus, 1987, 2000) contradicts previous interpretations (Bailey and McCallien, 1937; Rast, 1958) that this

is a folded sequence of formations now assigned to the Blair Atholl Subgroup and the lower Argyll Group, and that the contact with the Grampian Group is a 'slide'.

The present interpretation is supported by the clear correlation that may be made between this succession, albeit in a very condensed sequence, and the Lochaber and Ballachulish subgroups of the Appin Group in the type area (Figure 3.2). The latter succession, which contains thicker and more-fully developed correlatives of all of the formations seen in Strath Fionan, is illustrated by the GCR sites in the Loch Leven area (*River Leven*, *Nathrach*, *Rubha Cladaich*, *St John's Church*, *Onich*) and Appin area (*Ardsheal Peninsula* and *Lismore Island*) discussed elsewhere in this paper. Of particular significance in making this correlation is the clear similarity of the Meall Dubh Quartzite with the Appin Quartzite of the type area and, in its pebbly nature, its total dissimilarity with the Schiehallion Quartzite, with which it had been previously correlated.

Two other aspects of this GCR site are important in the context of the interpretation of the Grampian Fold-belt. Firstly, in general the site has an unusual wealth of porphyroblastic metamorphic minerals, including biotite, garnet, staurolite, amphibole, epidote and feldspar. In particular, the spectacular kyanite of the Meall Dubh Graphitic Schist was used in a study by Wells and Richardson (1979) to determine that the Dalradian of the Central Grampian Highlands has been buried to a depth of some 30 km.

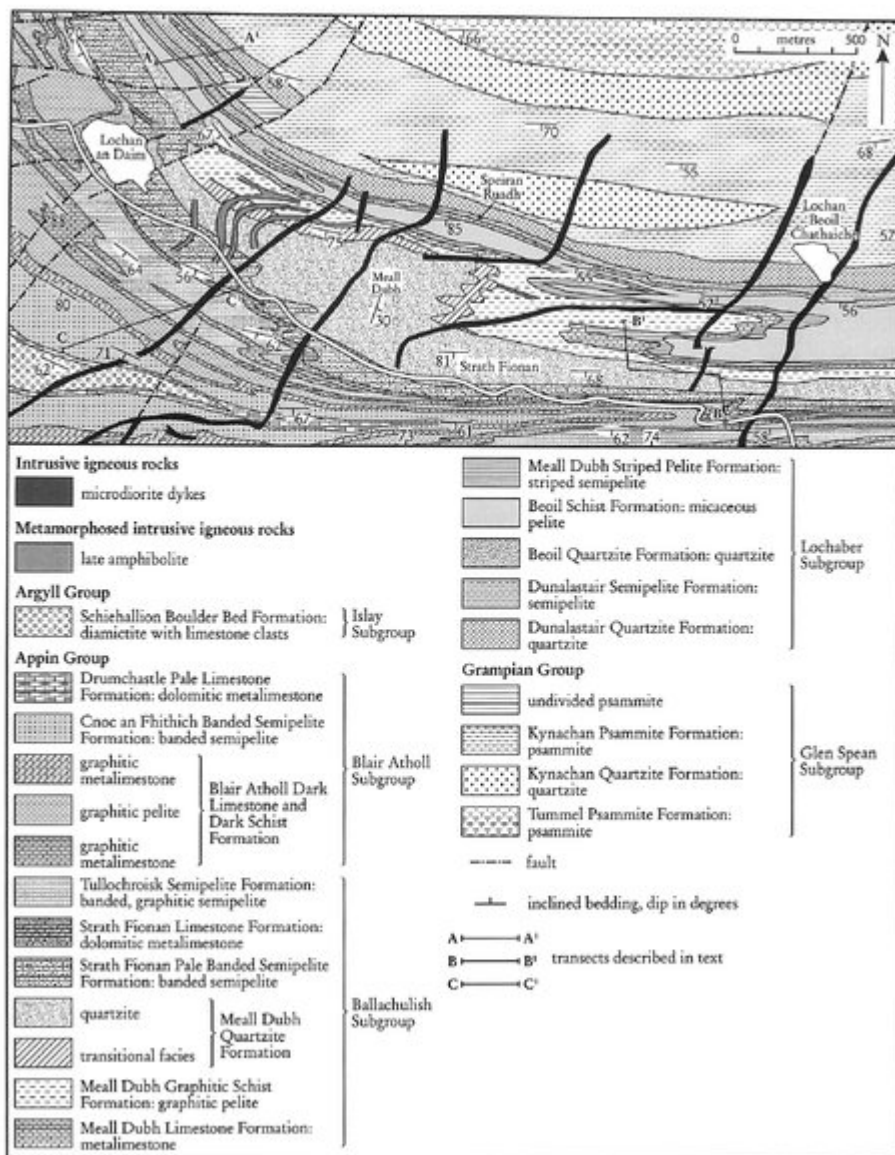
Secondly, the wealth of minor structures (folds, cleavages and lineations) in the site has allowed it to be shown that the rocks have undergone four distinct episodes of deformation (Treagus, 1987). The dominant set of minor structures, which can be confidently correlated with the regional D2, show from their consistent southerly vergence that the succession described lies on the northern limb of a major antiform. This is the regional Balliemore Antiform, the axial trace of which lies immediately to the south of the GCR site and is the complementary fold to the Meall Reamhar Synform described in the *Creag nan Caisean–Meall Reamhar* GCR site report (Treagus, 1987, 2000).

17.4 Conclusions

The Strath Fionan GCR site is of national importance in demonstrating the continuity of sedimentation between two of the major groups, the Grampian and the Appin, of the Dalradian Supergroup. Of particular importance is the unusual preservation of sedimentary structures in such strongly deformed rocks. The continuity of both the stratigraphical succession and of the structural history across the Grampian–Appin group boundary precludes this junction being interpreted as a major tectonic unconformity. A comparison can be made in this respect with the *River Leven* and *River Orchy* GCR sites, where the same conclusion has been reached. Neither is there convincing evidence for the presence of a major low-angled ductile dislocation, the Boundary Slide, which had been suggested by earlier researchers because of the high strain exhibited by units in the lower part of the Appin Group succession.

The site is critical to the reconstruction of the Dalradian sedimentary basin, particularly in the comparison of the very thin succession here with the much thicker equivalent sequences seen in other GCR sites in the Central Grampian Highlands (in the Loch Leven and Appin areas), as well as with those on Islay and on the Garvellach Islands in the South-west Grampian Highlands and with GCR sites in the North-east Grampian Highlands. The site reveals a quite exceptional development of minor-scale structural features which, in conjunction with those of other nearby GCR sites, help to demonstrate the presence of the major structures that make up the Grampian Fold-belt. Minerals that grew during metamorphism are also unusually visible to the naked eye in many of the rocks in the GCR site. The geochemical analysis of the mineral kyanite from this site has been of key importance in establishing the great depth of burial that this part of the Grampian Terrane has undergone.

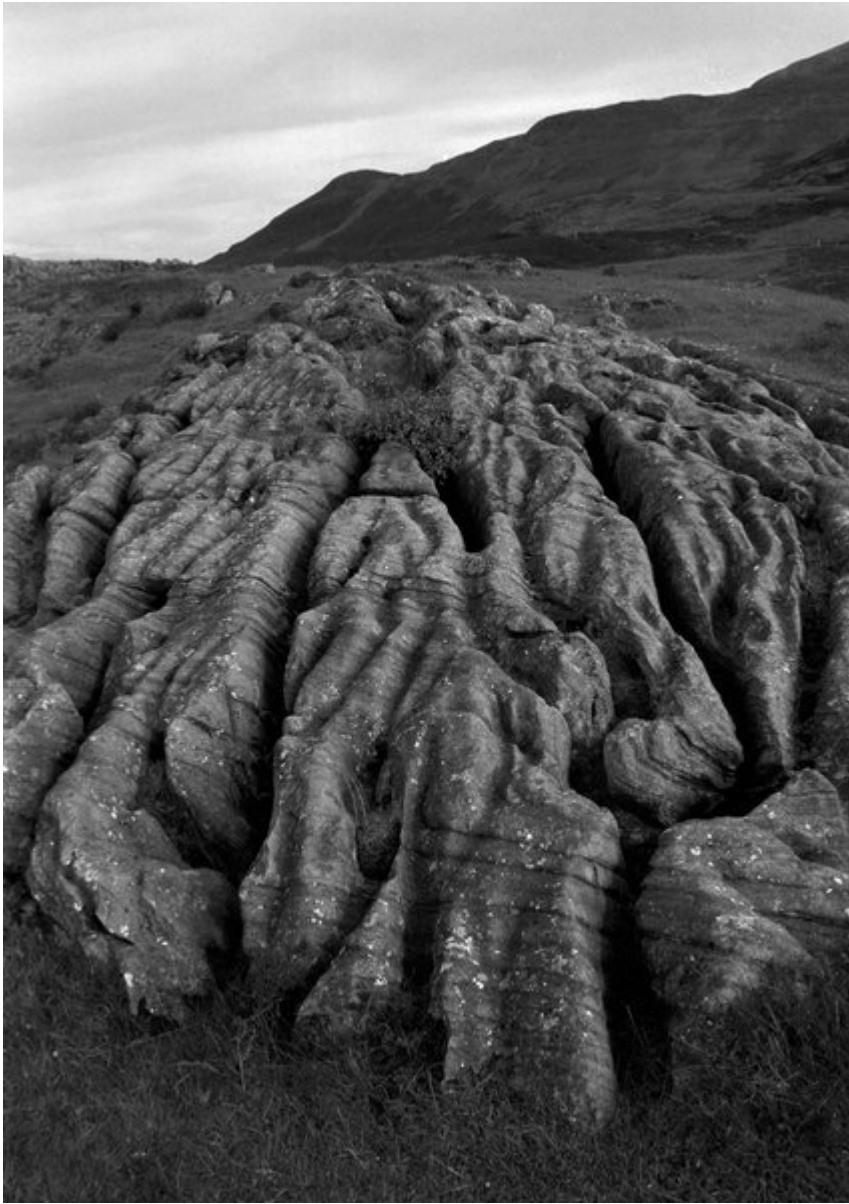
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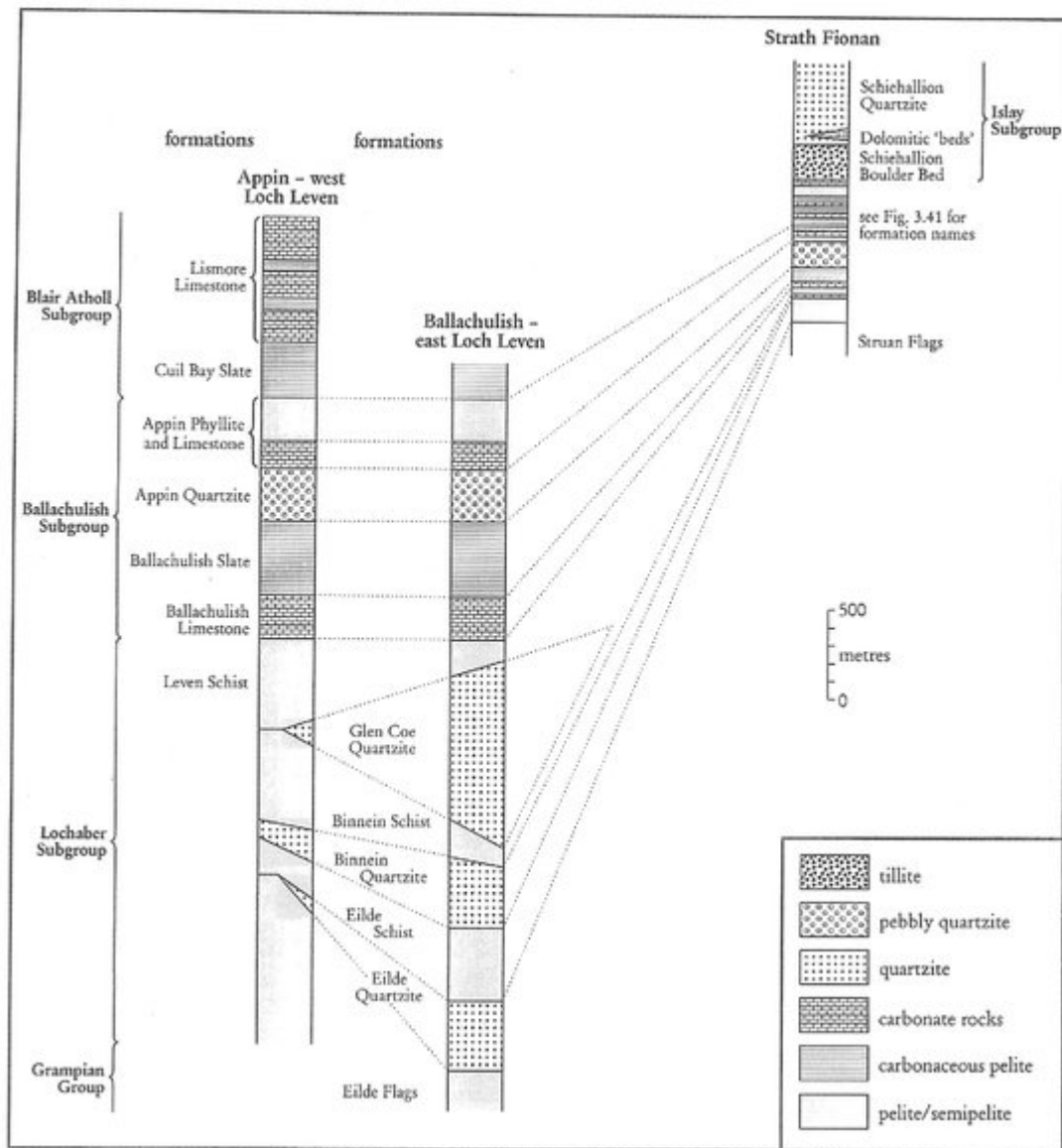
(Figure 3.41) Geology of the Strath Fionan area based on mapping by J.E. Treagus and P.A.R. Nell. After BGS 1:10 000 sheet NN75NW (1997) and Treagus (2000, figure 4).



(Figure 3.42) Thinly bedded Beoil Quartzite in Strath Fionan exhibits an F2 fold-pair, verging south in the centre of the picture. To the right of the F2 synform is a tight F1 closure folded by another F2 antiform. View to the east from [NN 721 576, c. 300 m north-east of Lochan an Daimh. Hammer head is 15 cm long. (Photo: J.E. Treagus.)



(Figure 3.43) The lower limestone of the Blair Atholl Dark Limestone and Dark Schist Formation in the hinge-zone of an F2 fold in Strath Fionan. View to the south-east from [NN 717 570], c. 200 m south-west of Lochan an Daimh. Outcrop is about 10 m wide. (Photo: J.E. Treagus.)



(Figure 3.2) Comparison of Dalradian successions in the Loch Leven and Schiehallion (Strath Fionan) areas.