4 Rubha Cladaich

[NN 120 610]–[NN 133 613]

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4.1 Introduction

The Rubha Cladaich GCR site, adjacent to the main road on the north shore of Loch Leven, provides important sedimentological and structural information in a section across three members of the Loch Treig Schist and Quartzite Formation in the Ballachulish Subgroup of the Appin Group. The sedimentary make-up of the three members (Glen Coe Quartzite, Binnein Schist and Binnein Quarzite), their transitional facies and their sedimentary structures can be seen clearly on clean glaciated surfaces. In addition, the evidence from minor structures supports the relative ages and geometry of the three principal phases of deformation in the region. Together with complementary information from the *Nathrach* GCR site, these structures can be used to demonstrate the D1 age of the dominant major fold in the area, the Kinlochleven Anticline. The rocks at this site are exceptionally rich in porphyroblasts both of garnet and of plagioclase, which can be related to the structural history.

The principal features of the GCR site have been described by Bailey (1960), Treagus (1974), and in a field guide to the Loch Leven area by Roberts and Treagus (1977b).

4.2 Description

This GCR site provides both sedimentological and structural information from the base of the Glen Coe Quartzite, down through the Binnein Schists into the top of the Binnein Quartzite in a series of shoreline exposures, complemented by road-cuttings (Figure 3.10). At the western margin of these exposures [NN 1216 6098] to [NN 1228 6098], the peninsula of Rubha Cladaich exposes glaciated surfaces of the thick-bedded (0.5–2 m) feldspathic Glen Coe Quartzite. The western edge of the exposure is part of a steep N-dipping ‘short’ limb of a major steeply-plunging fold, the long limb of which, dipping at 48–72° to the west-north-west, occupies the remainder of the exposure to the east. Cross-bedding, in 30 cm-thick sets younging to the south, is particularly well seen on the short limb, by the mouth of a small burn. Other sedimentary features that are seen in the quartzites on both limbs include ripple cross-lamination, slump folds and mud-flakes that are associated with thin pelitic beds (centimetres thick). The latter contain thin string-like concentrations of feldspar clasts up to 2 cm long.

The hinge area of the major fold, which is exposed on the main promontory to the east of the burn, has a vertical penetrative axial plane schistosity that strikes 072°. Calculated plunges of minor folds within the hinge are variable from steep (e.g. 80° to the south-west), through vertical, to 44° to 020°; the latter are presumed to be more typical of the regional plunge of the major folds (Treagus, 1976). The NNE-striking long limb of the fold is corrugated by metre-wavelength, open folds with axial-surfaces trending east-north-east that are locally associated with a widely spaced crenulation cleavage.

To the east of the main promontory the next exposures, around [NN 1233 6098], contain the Glen Coe Quartzite–Binnein Schist junction, showing a transition from metre-thick quartzites in semipelite into garnetiferous pelites with only thin (10 cm) beds of quartzite. The latter quartzites exhibit cross-bedding and channel structures that indicate younging to the west. In the Binnein Schists, porphyroblasts both of plagioclase feldspar and of garnet are common in the pelites. Both are wrapped by a dominant, near-vertical, crenulation cleavage (e.g. 070°/86°NW) that crosses the bedding (e.g. 020°/70°W) in a clockwise sense; minor folds related to the cleavage show consistent ‘S’ vergence and plunge to the south-west (e.g. 40° to 335°). Of particular importance, seen in the middle of this exposure, are several 10–20

cm-wavelength isoclinal folds (F1 in the interpretation below) that are clearly folded or are cross-cut by the dominant crenulation cleavage (S2) and its associated minor folds (F2) (Figure 3.11). These earlier folds, which have a penetrative schistosity (S1) parallel to their axial-surfaces, plunge steeply to the north-east and have an ‘S’ vergence. Particularly clear patterns produced by the interference of the two sets of folds are seen at the extreme edge of this exposure at about [NN 1249 6101]. Similar relationships can be seen on a steep glaciated surface farther east at[NN 1262 6004]. Locally, open folds (F3) with E-W-trending axial surfaces and a coarse crenulation cleavage, deform the earlier cleavages.

The junction of the Binnein Schists with the Binnein Quartzite is exposed in a road-cutting at [NN 1267 6017], where there is a transition over a distance of a metre from the typical Binnein Schist lithology, described above, into thinly-bedded (centimetre-thick) pure quartzite. The quartzite, which dips at about 50° to the west, becomes thicker-bedded eastwards, with 30 cm-thick units and clear cross-sets younging to the west that are best displayed near the end of the roadcut [NN 1284 6027], but also seen on the foreshore at [NN 1279 6020]. Also seen are folds of a metre wavelength, with a similar geometry to the dominant F2 set in the previous exposures, which plunge moderately to steeply to the south-west with an ’S’ vergence.

4.3 Interpretation

The almost continuous exposure across the two boundaries between the three members gives an exceptionally compact section in which the nature of this sedimentary succession, the detail of its sedimentary structures and its way-up can be studied.

Structurally, the importance of the site lies in the clear superimposition of the three regional phases of deformation. The folds and cleavage in the Glen Coe Quartzite are identifed as D1, as no earlier structure can be observed; their plunge and vergence are compatible with their position on the upper limb of the major downward-facing F1 Kinlochleven Anticline, which lies in the outcrops of Eilde Quartzite and Eilde Schist between here and the *Nathrach* GCR site to the east. In the adjacent Binnein Schists, the S1schistosity is intensely crenulated by the dominant S2 cleavage, but clear examples of F1 folds are also preserved (Figure 3.11). The D2 minor folds complement those seen at the same stratigraphical boundary in the *Nathrach* GCR site. Their plunge and vergence demonstrate that the Kinlochleven Anticline is cross-cut by the D2 structures and also support the interpretation of the geometry and position of the major F2 Stob Ban Synform to the west (see also the *Stob Ban* and *Tom Meadhoin and Doire Ban* GCR site reports). The growth of the garnet and plagioclase porphyroblasts can be seen to be associated with the development of the S2 cleavage that wraps them, both in thin section and in hand specimen (Treagus, 1974).

The third generation of minor structures is seen in the open folds of the Glen Coe Quartzite exposures and as the coarse ENE-striking crenulation cleavage in the Binnein Schists. These structures are related to the regional F3 Loch Leven Antiform, which is responsible for the deflection of the regional north-east strike into the south-east strike on the S side of Loch Leven (Treagus, 1974; (Figure 3.3)a; see also the *Nathrach* GCR site report).

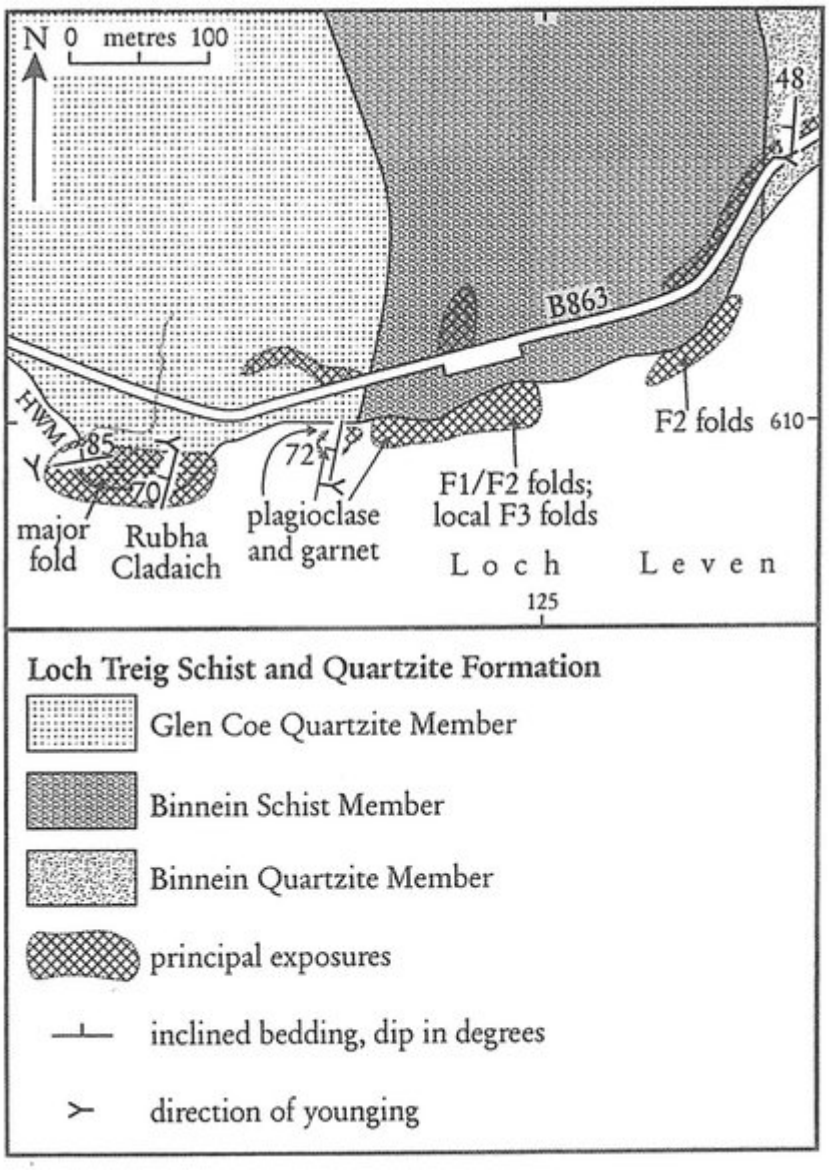
The interpretation of the D1 and D3 major structures given here agrees with the interpretation of Bailey (1960), which was supported by the minor structural data given by Treagus (1974). The latter author used the minor structures to propose the present three-phase history. However, Hickman (1976) refuted that the downward-closing fold between the present site and that at Nathrach is the closure of the F1 Kinlochleven Anticline, attributing it to a secondary phase, although he did not present any specific data to support this interpretation. His main argument, from the NW-striking exposures on the south side of Loch Leven, appeared to be that minor F1 folds plunge to the south-east on the south-west limb and to the north-west on the north-east limb and thus must be folded around the major closure. However, the data presented here and in the *Nathrach* GCR site report show that F1 minor folds exhibit a considerable variation in plunge from steep to the south-west, through vertical to gentle NE-plunging attitudes. Allowing for the late swing of strike across Loch Leven, this variation in fold geometry is similar to that recorded by Hickman, but here it can be seen within a single F1 major fold limb. Furthermore, there is no evidence from post-D1 minor structures to support the existence of a major secondary synform to the east of the Rubha Cladaich GCR site.

4.4 Conclusions

The Rubha Cladaich GCR site provides both essential sedimentological and structural information for the interpretation of the Dalradian of the western side of the Grampian mountain belt. Firstly, it allows the establishment of the stratigraphical succession of the lower part of the Appin Group (the Glen Coe Quartzite, Binnein Schist and Binnein Quartzite members of the Loch Treig Schist and Quartzite Formation) in an unusually compact and continuous shore section. Sedimentary structures, which give information concerning the conditions of sedimentation, as well as the way-up of the succession, are particularly well preserved on clean glaciated surfaces. Similarly, these surfaces provide clear evidence of minor tectonic structures (folds and cleavages) of three generations. Study of these structures, particularly in the context of adjacent GCR sites allows the geometry and relative age of major folds of the three generations to be understood.

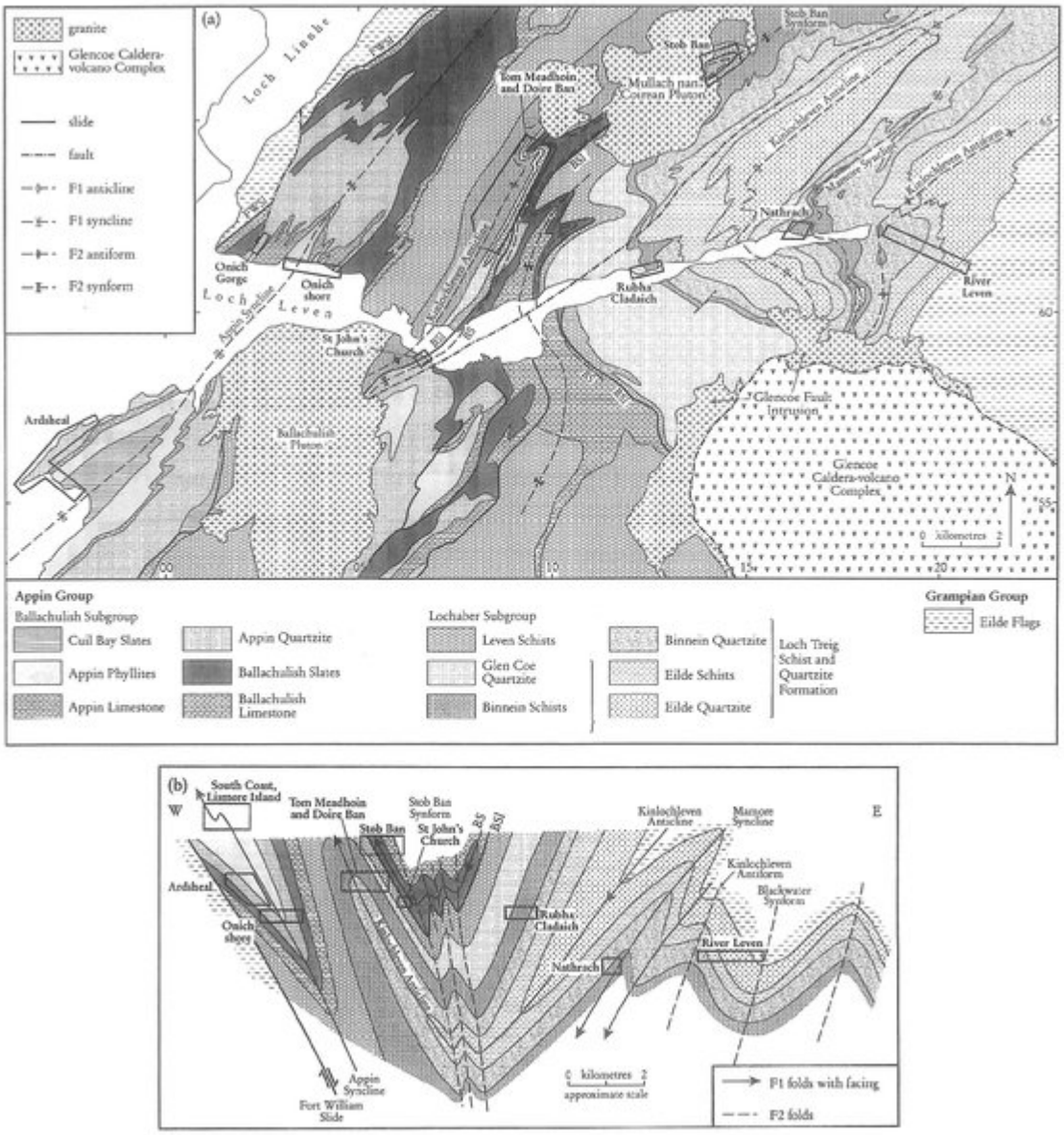
This site complements the *Nathrach* GCR site in demonstrating the dramatic large-scale closure of the Kinlochleven Anticline, the most important of the early regional folds in the area, which is here totally inverted by the second phase of deformation. It also exhibits still later folds, with their associated cleavage, which are essential to the understanding of the regional swing in the trend of the beds and earlier structures through 90° across the eastern end of Loch Leven.

References



(Figure 3.10) Map of the coastal section at the Rubha Cladaich GCR site, showing the outcrops of the Glen Coe Quartzite, Binnein Schists and Binnein Quartzite. Principal exposures are outlined.

(Figure 3.11) D2 folds and cleavage in the Binnein Schists at the Rubha Cladaich GCR site. F1 folds can be seen, for instance, at the tip of the pencil. Pencil is 10 cm long. (Photo: J.E. Treagus.)



(Figure 3.3) (a) Map of the Loch Leven area, showing outcrops of the main stratigraphical units, major structures and locations of GCR sites. BS Ballachulish Syncline, BaSl Ballachulish Slide, FWSl Fort William Slide (b) Diagrammatic profile of the area shown in (a), looking up-plunge of F1 folds and showing position of GCR sites. Key, abbreviations and horizontal scale as in (a).