3 Nathrach

[NN 164 624]

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3.1 Introduction

The Nathrach GCR site, which is on a well-exposed hillside above the main road on the north side of Loch Leven west of Kinlochleven, has both stratigraphical and structural importance. Firstly, it contains fine exposures of the Binnein Schist and Binnein Quartzite members of the Loch Treig Schist and Quartzite Formation (Lochaber Subgroup) and of their transitional junction (Figure 3.7). The exposures of quartzite are rich in sedimentary structures. Secondly, the interbedded thin quartzites and pelites of the transitional beds contain minor structures, unrivalled for their clarity (Figure 3.8), which give important information on both the geometry and position of major folds of two deformation phases. The locality is therefore critical, together with other GCR sites (*River Leven, Rubha Cladaich, St John's Church, Tom Meadhoin and Doire Ban* and *Stob Ban*) to the interpretation of the large-scale recumbent refolded folds which characterize the Loch Leven–Ballachulish area.

The stratigraphy and the structure of the GCR site have been described by Bailey (1960) and Treagus (1974). A description of the site is also included in a geological field guide to the Loch Leven area by Roberts and Treagus (1977b).

3.2 Description

There are three areas of interest in this GCR site. The principal interest is in the structure of the Binnein Schists, as displayed in a series of prominent NW-facing exposures about 50 m long at around [NN 1656 6235] ((Figure 3.7), locality A). The member here comprises finely bedded pelite and semipelite with some interbedded centimetre- to 0.5 metre-thick white quartzite beds. Cross-bedding in these pure quartzites, which are of a similar facies to the Binnein Quartzite, youngs to the north-west in the near-vertical NE-striking beds. The exposures provide numerous examples of tight folds (F2 in the interpretation below) with centimetre- to metre-scale amplitude and wavelength (Figure 3.8). At the south-western end of the crags, the plunge of these folds is at steep angles (70–80°) to the south-west, but towards the north-eastern end they plunge steeply to the north-east. The penetrative fabric of the pelite, which is subparallel to the bedding, has been affected by a tight crenulation cleavage (S2), which is near vertical, NE-striking and axial planar to the folds; the penetrative fabric in the semipelite is tightly folded together with the bedding. The vergence geometry of the folds and of the bedding in relation to the crenulation cleavage is of an 'S' type (assuming an average vertical plunge). In certain exposures it is possible to see that earlier folds (F1) are deformed by this main set; neither the vergence nor the plunge of these early folds is easily measured, but the nature of the interference patterns shows that they are not precisely co-axial with the later set. The earlier folds have the penetrative cleavage (S1) in the semipelite parallel to their axial surfaces. A weaker, NNE-trending, crenulation cleavage associated with more-open folds is developed locally; this is the third set of structures more fully described at locality C, below.

The second area of interest is the structure of the Binnein Quartzite, best seen in prominent crags centred about [NN 1640 6237], some 10–50 m west of a sharp change of slope which marks the Binnein Quartzite–Binnein Schist junction ((Figure 3.7), locality B). Here, the member consists of white quartzite, well bedded (10–90 cm-thick beds) with rare semipelite and pelite units. Cross-bedding, not easily seen near the junction with the Binnein Schists, is seen to young consistently to the south-east in the near-vertical NE-striking beds. Of particular interest are thin (10 cm) beds of quartzite, interbedded with the pelite and semipelite, which commonly display well-developed tight folds. These asymmetric folds, with a short limb length of some 10–20 cm, plunge at 30–50° to 070°, have a 'Z' geometry and have a penetrative schistosity in the semipelite parallel to their axial-surfaces, as noted in the F1 folds at locality A (Figure 3.9).

In the adjacent pelites, a crenulation cleavage (of the type noted above related to the later F2 folds) is developed, which transects the F1 folds; folds related to this cleavage are not developed here, although they are seen, with the characteristic ‘S’ geometry, in more schistose lithologies nearer to the junction with the Binnein Schists. Similar relationships can be observed elsewhere near this junction (Figure 3.7).

The third area is a series of crags at the top of a small hill near the road at [NN 1630 6205] ((Figure 3.7), locality C), which exposes Binnein Schists of the type described at locality A, and in a similar structural position. Metre-thick quartzites, north striking and near vertical, display excellent cross-sets younging to the west. The quartzites are affected by open folds, and the interbedded pelites display the development of an axial-planar, wide-spaced (1 cm), crenulation affecting the two earlier cleavages described above. The axial surfaces of these crenulations strike east-north-east and are near vertical; the plunge of this third set of folds is approximately vertical.

3.3 Interpretation

The Nathrach GCR site is located across the transitional junction between the Binnein Quartzite and the Binnein Schists and, although a totally continuous section is not exposed, the abundant easterly-younging cross-bedding in the quartzites at locality B leaves no doubt that the schists are the younger member. In a regional context, this junction is on the western, sub-vertical, limb of a tight, upright, antiform which closes to the north-east on Sgor an Fharain (180 640) (Figure 3.3)a. The same transitional junction on the eastern limb of the fold can be examined east of the Nathrach Burn around [NN 170 627] where cross-bedding youngs to the west (Figure 3.7). Bailey (1960), from stratigraphical considerations, proposed that this fold (named the Mamore Syncline by Treagus, 1974) is a downward-facing D1 structure, a major subsidary fold on the eastern limb of the regional Kinlochleven Anticline. This proposal is consistent with the minor structures observed in the western area of the GCR site at locality B, which show that the rocks face downwards on the first penetrative cleavage, related to minor folds that must lie on the western limb of a major syncline (see also Treagus, 1974). These observations are complemented by those at the *Rubha Cladaich* GCR site, which lie on the western limb of the downward-facing F1 Kinlochleven Anticline.

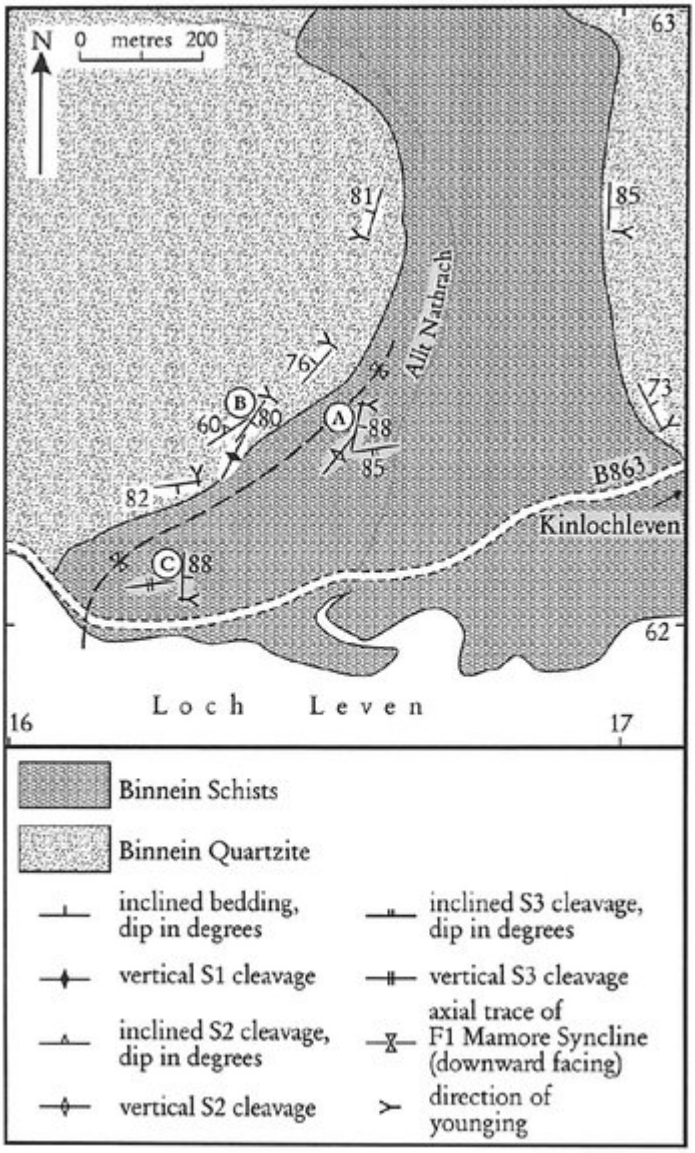
To the east of the junction of the Binnein Quartzite and Binnein Schists, at locality A, interbedded quartzites within the Binnein Schists young towards the west. Since the crenulation cleavage and related minor folds (D2 of the regional structure) have the same vergence here as in locality B, the fold between the two localities must either be a subsidiary F1 fold related to the Mamore Syncline or the major fold itself. The importance of these observations is to show that the major reversals of younging in the area are the product of the downward-facing D1 folding and not of the D2 phase. Similarly, the consistent vergence of the D2 structures here and in the *Rubha Cladaich* GCR site, on the opposing limb of the Kinlochleven Anticline, can be used to demonstrate the D1age of that fold.

Locality C exhibits examples of a third generation of minor folds (F3), and a related E–W-trending crenulation cleavage (S3). Both are geometrically associated with the major swing in strike, to a south-east direction, of all earlier structures across Loch Leven (Figure 3.3)a. Treagus (1974) suggested that this change in strike (the Loch Leven Fold) on the south side of the loch might be the result of the intrusions of the Glen Coe Caldera-volcano Complex of late-Silurian age. The re-interpretation of this volcanism in a NW-orientated graben, resulting from regional NE-directed tension or from a transtensional scenario (Moore and Kokelaar, 1997), might account for such a deflection in the adjacent Dalradian rocks.

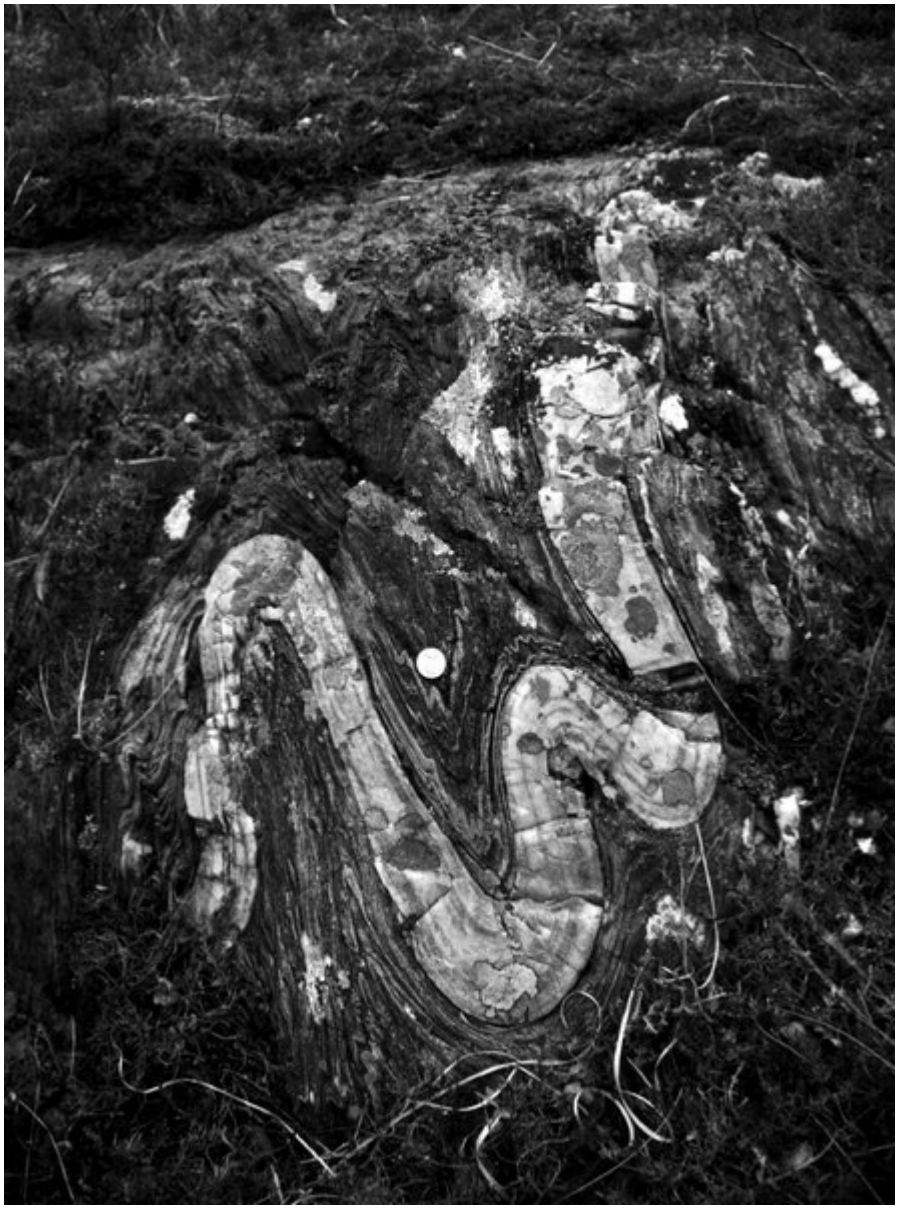
3.4 Conclusions

The importance of the Nathrach GCR site lies in its wealth of sedimentary structures across the junction between two members of the Loch Treig Schist and Quartzite Formation (Lochaber Subgroup) and in its abundant minor tectonic structures (folds and cleavages) of unrivalled clarity. Taken together, these structures demonstrate that the earliest major folds, of many kilometres amplitude and originally probably flat-lying, have been bent by later forces to assume remarkable, totally downward-facing (i.e. upside-down) attitudes. Even later forces have twisted the earlier folds yet again through 90° to change the whole grain of the country rock for several tens of kilometres, which may be related to the tensional opening of the crust associated with development of the Glen Coe Caldera-volcano to the south.

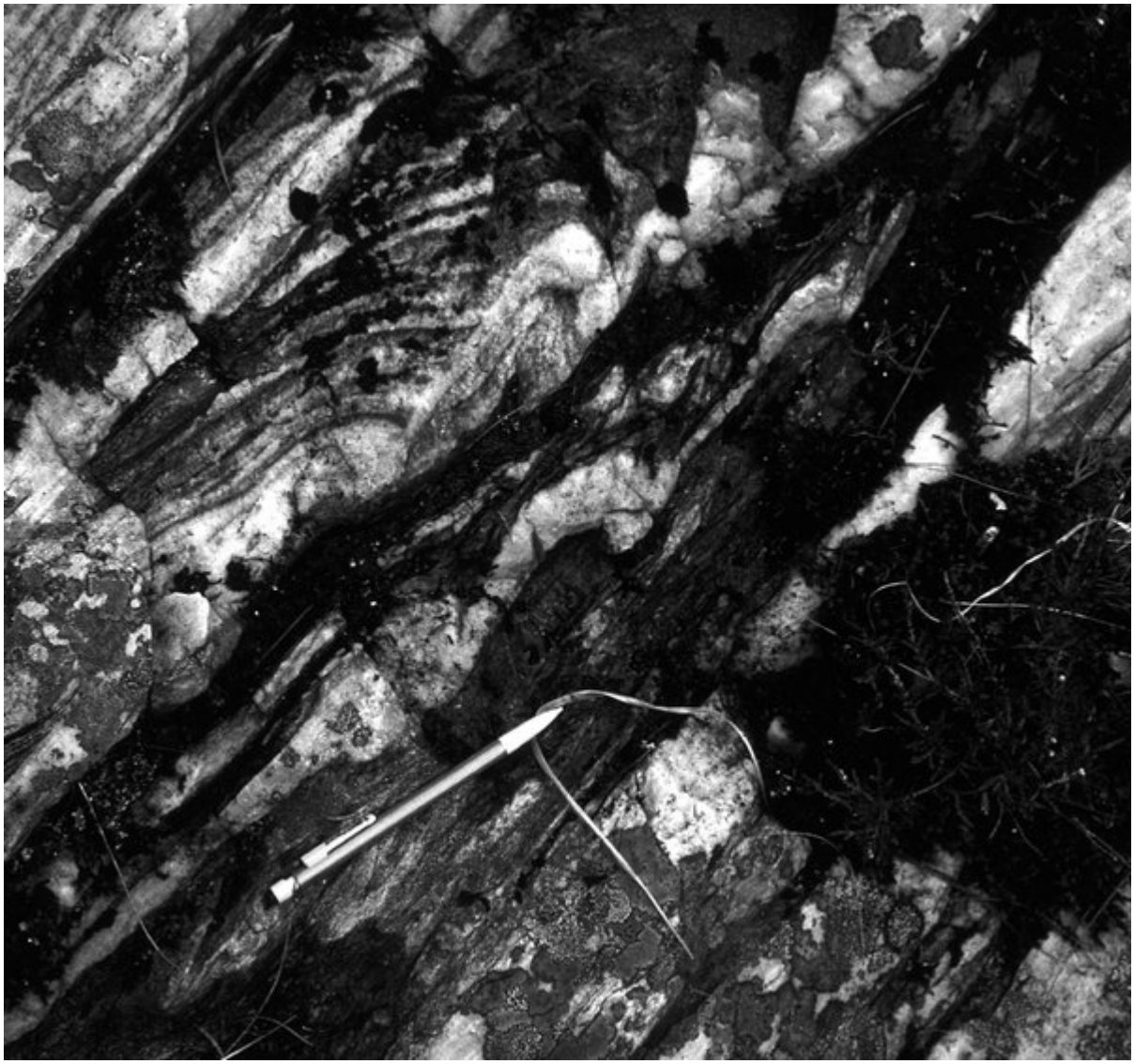
References



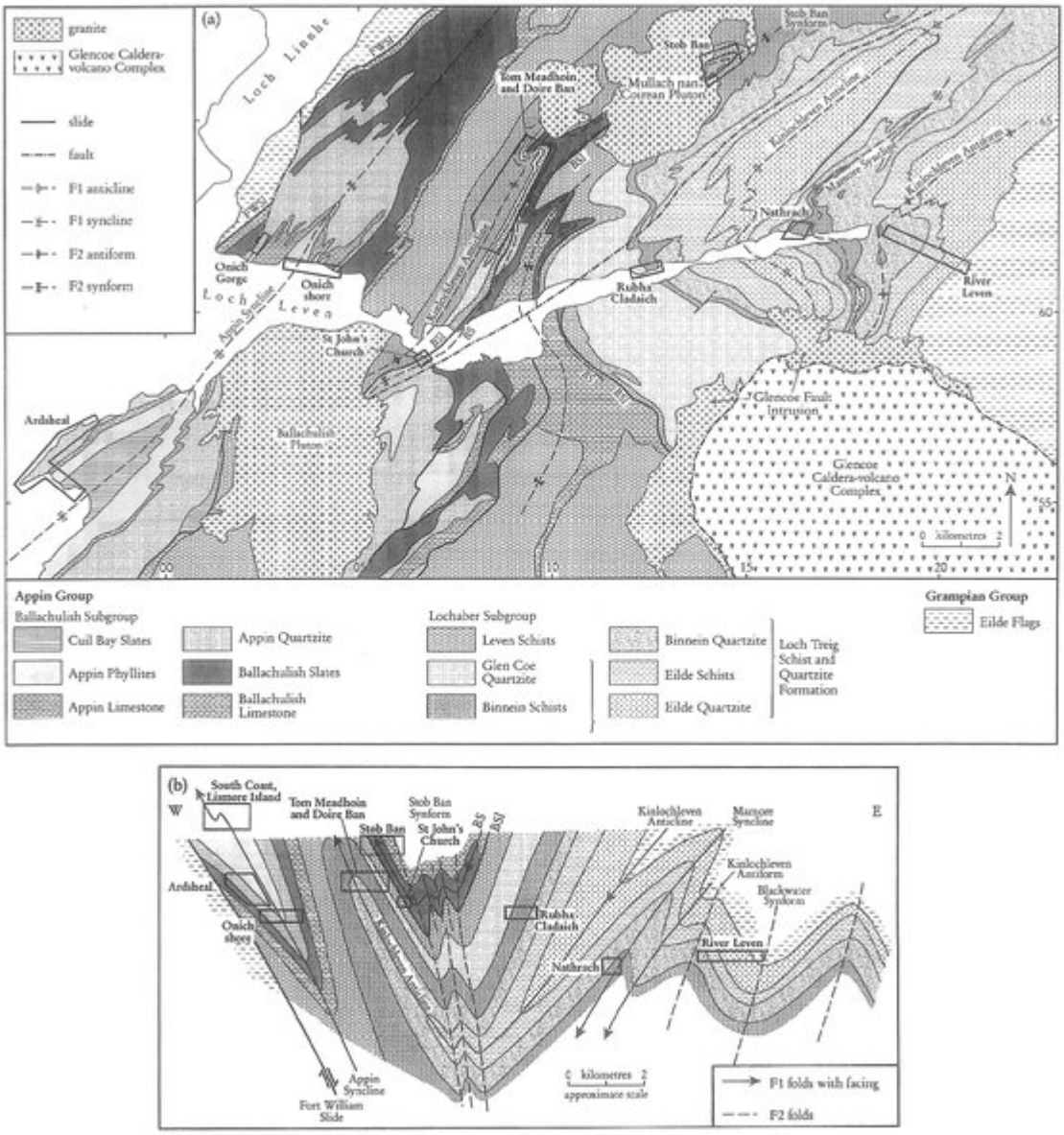
(Figure 3.7) Map of the area around the Nathrach GCR site, showing the boundary between the Binnein Quartzite and the Binnein Schist on the two limbs of the F1downward-facing Mamore Syncline. At localities A, B and C, relations between bedding and the three cleavages are shown, as appropriate. The relation of bedding to the direction of younging is shown at localities along the boundary as well as at localities A and C, within the Binnein Schists.



(Figure 3.8) Thinly-bedded quartzites and semipelites in the Binnein Schists, tightly folded by F2 folds that plunge steeply to the north-east at locality A, (Figure 3.7) in the Nathrach GCR site. Coin is 25 mm diameter. (Photo: J.E. Treagus.)



(Figure 3.9) Semipelites interbedded in the Binnein Quartzite, as seen on a surface sloping gently to the south-east (bottom right) at locality B, (Figure 3.7) in the Nathrach GCR site. Cross-bedding near the top left corner youngs to the south-east and faces down on the axial-planar fabric of the minor folds; these folds, which are of D1 age, plunge at 40° to the north-east and verge to the north-east. Not clear in the photograph is the S2 crenulation cleavage, which cross-cuts the F1 folds parallel to the length of the pencil. Pencil is 15 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).