21 Ben Lawers

[NN 621 368]–[NN 595 415]

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21.1 Introduction

This GCR site, on the western and southern flanks of the Ben Lawers mountain range, illustrates typical structures within the inverted limb of the Tay Nappe, the major fold that dominates the structure of the south-eastern Grampian Terrane. It also contains the type locality of one of the major post-nappe folds, the F4 Ben Lawers Synform. In addition to the structure, the exposures described within this very large GCR site, have been selected to illustrate the stratigraphy of the four highest formations of the Argyll Group in the Central Grampian Highlands.

The regional inversion of the succession on the lower limb of a major fold has long been established (the Iltay Nappe of Bailey, 1922 or the Tay Nappe of Shackleton, 1958). The details of the local structure, particularly that of the Ben Lawers Synform, have been studied by Elles (1926), Elles and Tilley (1930), Treagus (1964b) and Nell (1984). The site, which belongs to the National Trust for Scotland and is famous for its plants and wildlife, has a visitor centre that is much visited by the general public who would benefit from the availability of more geological information.

21.2 Description

The localities are described from south to north, up the southern slopes of Ben Lawers which, as the succession is inverted, means that the descriptions progress approximately from the youngest to the oldest formations (Figure 3.49). Three phases of deformation can be discerned in these rocks, designated D1, D2 and D4 in the descriptions below; the attribution to these regional phases is justified in the subsequent ‘Interpretation’.

The youngest formation represented, the Loch Tay Limestone of the Tayvallich Subgroup, is seen in the small quarry at [NN 6212 3678] ((Figure 3.49), locality 1). The dip of the beds (some 30° to the north-west) in the semipelite laminae in the limestone is typical of the regional dip on the south limb of the F4 Ben Lawers Synform. A gently NE-plunging lineation (e.g. 10° to 025°) results from the intersection of bedding and a nearly bedding-parallel schistosity (S2), dipping less steeply to the north-west, and from the hinges of rare NW-verging isoclinal F2 folds. Pelites within the limestone show a steep NW-dipping S4 crenulation cleavage.

A well-exposed section from the next oldest formation, the Ben Lui Schist of the Crinan Subgroup, through the Farragon Volcanic Formation and into the Ben Lawers Schist of the Easdale Subgroup, is seen in the Burn of Edramucky from [NN 6184 3725] to [NN 6125 3910] (locality 2). In the Ben Lui Schist, below and above the road at [NN 6145 3756], the quartz-rich, garnetiferous, locally graphitic, interbedded semipelites and pelites show structural features similiar to those described above for the Loch Tay Limestone. NW-verging folds are well developed, with a penetrative axial-planar S2 schistosity and with plunges at low angles varying in trend from 050–020°. Going up the burn section, the north-north-west dip of the bedding gradually increases to about 50° at the Farragon Volcanic Formation junction [NN 6125 3910], and the F2 folds are more-constantly ESE-trending, with a northerly vergence. The latter formation, comprising finely interbedded semipelites and amphibolites, is exposed in the river gorge and is transitional northwards into the quartzites and calcareous schists of the Ben Lawers Schist. The Farragon Formation here contains small, NW-verging, tight F2 folds which refold earlier F1 isoclines.

The Ben Lawers Schist is not well exposed in the burn and the rocks at this structural level are better seen in the road section at [NN 601 390] (locality 3), described in detail by Treagus (1964b). Here, upright metre-scale folds, associated

with a well-developed ENE-trending S4 crenulation cleavage, are seen to refold north-verging, tight F2 folds, related to a subpenetrative schistosity (Figure 3.50). The earlier folds, which here trend between west-north-west and north-west, themselves fold an earlier S1 schistosity and a mineral (quartz-chlorite) lineation with a more north-north-westerly trend. F1 isoclines with a north-west to west trend and northerly vergence are seen rarely and appear to be associated with the earliest schistosity and mineral lineation. The upright F4 folds have an enveloping surface that defines a gentle northerly dip of the major fold limb, near to the axial zone of the Ben Lawers Synform. Farther north, near the road on the east side of Lochan nan Lairige at about [NN 600 406], and on the hillside above, the same generation of F4 folds are seen to have a neutral vergence in the hinge-zone of the Ben Lawers Synform. The hinge-zone is very well seen looking across the lochan to the cliff section on its west side in which the bedding and the upright S4 cleavage are apparent on a grand scale.

The Ben Lawers Schist is not well seen on the north limb of the Ben Lawers Synform but at the tunnel portal at the north end of the lochan ([NN 5953 4115]; locality 4), the Farragon Volcanic Formation is exposed, with bedding here dipping at a low angle to the south. Many loose specimens provide examples of tight F2 folds that rarely show refolded F1 isoclines, subparallel to a strong hornblende lineation.

Within the Ben Lawers Schist on the north limb of the Ben Lawers Synform, there is an isoclinal infold of schistose graphitic pelite, assigned to the Ben Eagach Schist Formation; this is exposed on the north flank of Meall Corranaich. In the core of the fold, the graphitic pelites are transitional into schistose pebbly quartzites of the Carn Mairg Quartzite Formation. The two limbs of this fold, both dipping at moderate angles to the south-east, are exposed in a burn between [NN 624 433] and [NN 633 428] and in two burns to the south-west [NN 624 426], north limb and [NN 625 416], south limb) (locality 5). In these exposures, the plunge of the tight F2 fold-set is at moderate angles (10–40°) to the east-south-east, with vergence both of the folds and of the axial-planar schistosity/bedding intersection consistently to the north; these folds are overprinted by the upright S4 crenulation cleavage. The infold must of D1 age, pre-dating the D2 and D4 deformation phases.

21.3 Interpretation

The exposures described in this GCR site have long been acknowledged to lie on the inverted limb of the Tay Nappe, where they are affected by the later Ben Lawers Synform (e.g. Elles and Tilley, 1930; Treagus, 1964b). The dominant north- to NW-verging folds with the penetrative to subpenetrative axial-planar schistosity are of the regional F2 generation, which is considered to be the main phase associated with the generation of the Tay Nappe (Harris *et al*., 1976). The axial trend of the F2minor folds and of the S0/S2 intersections, which is N–S in the Flat Belt south of the site, curves progressively through the area of the site from north-north-east in the south through north-east to east and then east-south-east in the north. Further research in the Ben Lawers area might contribute to the understanding of this phenomenon and of the evolution of the Tay Nappe.

The regional D1 phase is represented by the earlier fabric that can be seen to be crenulated by the S2 cleavage planes, and by the small-scale isoclines and mineral lineation in the Ben Lawers Schist and the Farragon Formation. Data are too sparse to state a trend or vergence for these structures, though the mineral lineation appears to have a north-north-west trend, both in the Farragon Formation and in the Ben Lawers Schist, similar to that widely reported elsewhere in the Flat Belt. The major infold of the Ben Eagach Schist and Carn Mairg Quartzite in the Meall Corranaich exposures is overprinted by the D2 structures and thus must also be of D1 age; from its outcrop pattern it has a north-east trend and thus must have been (at the time of D2) an anticline facing south-east. According to Treagus (1987, 2000) these major F1 folds originally faced steeply upwards.

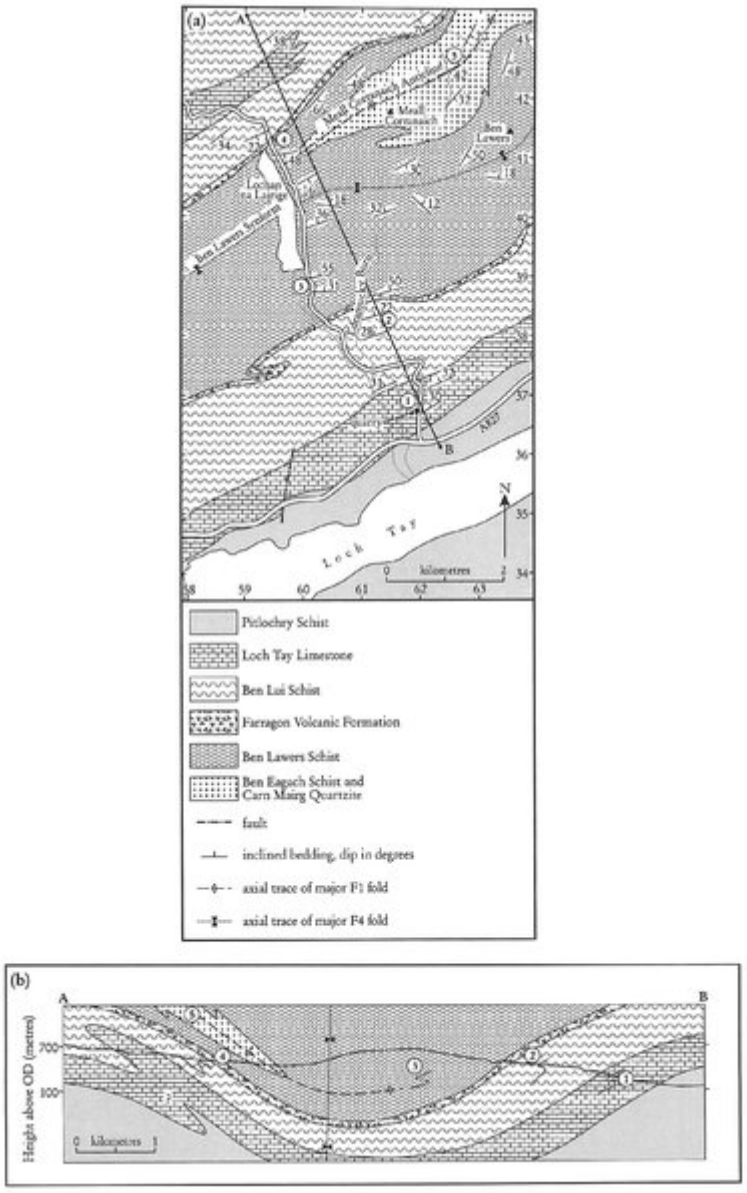
The major fold that affects bedding and S2 within the area of the GCR site is the regionally important F4 Ben Lawers Synform, a gentle deflection of the originally subhorizontal limb of the Tay Nappe. The fold is associated, in all lithologies but particularly within the Ben Lawers Schist, with upright intermediate- and small-scale folds trending east-south-east and their axial-planar crenulation cleavage. The vergence relations of the small-scale folds and of the cleavage across the major fold are particularly clear.

21.4 Conclusions

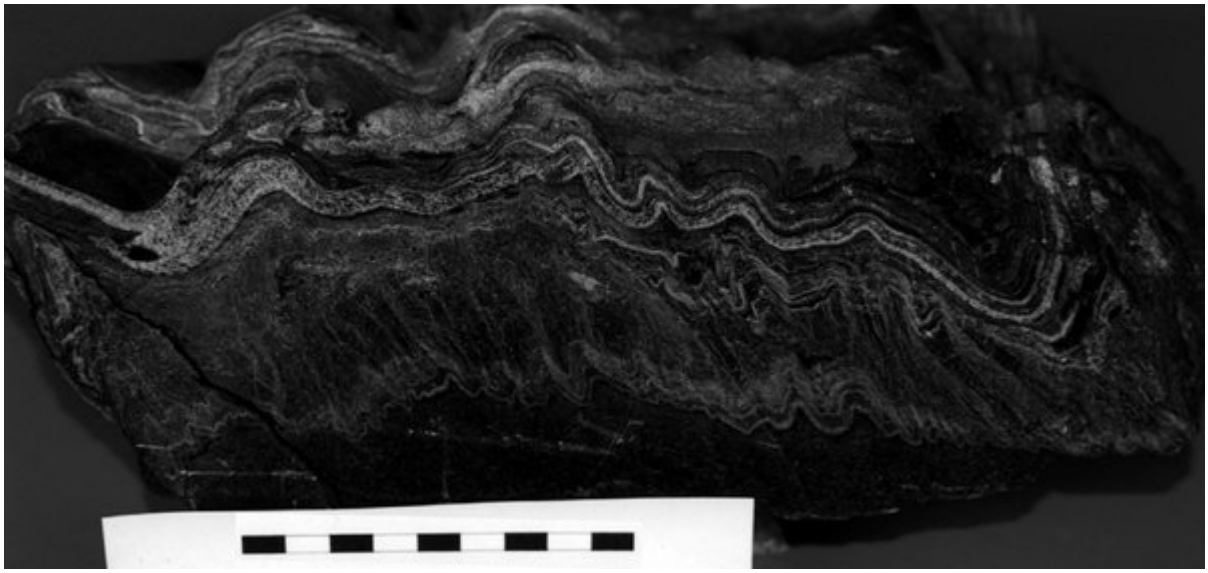
The Ben Lawers GCR site provides exceptional sections through four of the main formations of the Argyll Group and is of national importance in providing remarkably clear evidence of the total inversion of the sequence in this part of the Central Grampian Highlands, on the lower limb of a major early fold, the Tay Nappe. These upside-down rocks constitute the Flat Belt, which extends south-east across strike for 25 km to the Highland Border and for some 250 km laterally along strike, and dominates the structure of the south-eastern Grampian Terrane. Two generations of minor structures, folds and cleavage planes, related to the D1 and D2 movements that produced the nappe are well displayed.

Within the area of the GCR site another major fold that later folded the inverted rocks, is totally displayed, together with associated minor structures. This F4 fold, the Ben Lawers Synform, is one of the most important late folds in the overall Dalradian structure.

References



(Figure 3.49) Map and cross-section (A–B) of the area south-west of the Ben Lawers mountain range, showing localities 1–5, described in the text. Boundaries are based on the original Geological Survey 1:63 360 Sheet 46 (1900), except those of the Farragon Volcanic Formation. The latter boundaries are extrapolated from observations at localities 2 and 4, assuming a constant thickness. Structural data is from Nell (1984) and Treagus (1964b and unpublished). The geometry of folds shown at the key localities on the cross-section are representative of the vergence of the F2 folds.



(Figure 3.50) Cut surface of a typical calcareous schist of the Ben Lawers Schist Formation from the south-east shore of Lochan na Lairige [NN 601 393]. The S4 crenulation cleavage is well developed in the lower part of the specimen, while the calcareous quartzite bed near its top exhibits open F4 folding, which at the left-hand edge refolds a tight F2 fold-pair. Scale in centimetres. (Photo: J.E. Treagus.)