2 River Leven section

[NN 191 619]–[NN 205 189]

J.E. Treagus

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2.1 Introduction

The River Leven, east of Kinlochleven, provides a virtually continuous section, from the uppermost formation of the Grampian Group (the Eilde Flag Formation) through the three lowest members of the Loch Treig Schist and Quartzite Formation at the base of the Appin Group (the Eilde Quartzite, the Eilde Schists, and the Binnein Quartzite) (Figure 3.5). Its importance lies in the fact that a sedimentary transition between the Grampian and Appin groups can be clearly demonstrated. In addition, structural information from these rocks, in conjunction with that from other GCR sites around Loch Leven to the west, enables the large-scale tectonic picture of the western Grampian fold-belt to be understood. The exposures in the present-day bed and banks of the river are complemented in the east by those in an old course of the river and in the west by exposures adjacent to a pipeline.

The stratigraphical succession and the broad structural relationships of the Kinlochleven area have been described by Bailey (1960), with detailed structural data relating to the two regional phases of deformation being provided by Treagus (1974). A description of the GCR site was included in a guide to the Loch Leven area by Roberts and Treagus (1977b). A different interpretation of the structure was proposed by Hickman (1978), but this was refuted by Roberts and Treagus (1980).

2.2 Description

The GCR site extends from the youngest rocks at [NN 1910 6186], just west of the old bridge across the River Leven at Kinlochleven, east to the oldest at [NN 2047 6088], some 1.7 km upstream (Figure 3.5). At the former location, and for some 400 m upstream, are excellent exposures of the well-bedded, pure white, Binnein Quartzite with plentiful cross-bedding that youngs consistently to the west in vertical rocks (Figure 3.6). Characteristic rusty spots, a few millimetres in length are seen elongated parallel to a steep west-dipping cleavage in interbedded pelites. The transitional junction with the Eilde Schists is exposed in the river at about [NN 1950 6173]; younging in quartzite ribs immediately east of the junction is to the west.

The Eilde Schists are dark-grey pelites and semipelites with ribs of quartzite and feldspathic psammite, particularly near the top and bottom transitional beds, where carbonaceous and calcareous beds are also more common. Much of the accessible outcrop is in the flat limbs of folds, which are knee-shaped and tens of metres in wavelength; these folds verge north-west with an axial-planar, steep NW-dipping, intensely-developed, crenulation cleavage. The junction of the Eilde Schists with the Eilde Quartzite is exposed at about [NN 2006 6150], on the vertical limb (some 50 m wide and striking 037°) of a major fold; to the east a flat limb, some 100 m wide is exposed at waterfalls, where inverted cross-bedding and slump-folds are excellently displayed in the feldspathic quartzites. The dip then gradually increases to the east across a major fold hinge, to return to vertical at about [NN 2025 6606]; some good exposures are seen in the old river course which runs north-west from here. Associated with this major fold are small-scale folds in thin quartzite beds and a steep axial-planar crenulation cleavage in the pelites.

The junction with the Eilde Flags at the top of the Grampian Group is easily identified at the point where an overflow channel from the pipeline to the south joins the river at [NN 2026 6598]. Thin-ribbed psammites and semipelites occur to the east of the reddened quartzites of the Eilde Quartzite, with typical Grampian Group thicker-bedded feldspathic psammites coming in immediately east of a porphyritic microdiorite dyke. Westward-younging cross-beds and

slump-folds in the steep east-dipping rocks are well-seen throughout, but one 5 m-wide unit, between two waterfalls on the north bank, displays 10 cm- to 1 m-thick beds of slump folds particularly well, together with 50 cm-thick beds of unusually pebbly psammites. Pebbles in the latter are strongly elongated, up to a length of 4 cm, in the plane of the dominant, steep west-dipping, crenulation cleavage. Cleavage/bedding intersections are sub-horizontal (e.g. 5° to 062°).

2.3 Interpretation

The section in the River Leven is so unbroken and the way-up indicators are so unambiguous, that there can be no doubt that it provides a continuous stratigraphical section from the Eilde Flags (oldest), at the top of the Grampian Group, through the Eilde Quartzite and the Eilde Schists into the Binnein Quartzite, the lowest members of the Loch Treig Schist and Quartzite Formation at the base of the Lochaber Subgroup in the Appin Group. Most importantly, the attitude and style of the minor structures is consistent throughout the section and there is no evidence for a tectonic or metamorphic break at the junction between the Grampian and Appin group rocks. This observation became important with the assertion by Piasecki and van Breeman (1983) that rocks near Aviemore, which they assigned to the lower part of the Grampian Group, share a structural and tectonic event, then dated at 750 Ma, with underlying migmatitic rocks. Since there is no evidence in the Appin Group of events of this age, it appeared at that time that there must be a tectonic and/or metamorphic break within, or at the top of, the Grampian Group. However, since all of the rocks with evidence of a 750 Ma or older event (the date has subsequently been revised to c. 800 Ma) are now regarded as part of the pre-Grampian Group Badenoch Group (see Leslie et al., 2013), such an interpretation is no longer necessary.

The Grampian–Appin group junction exposed in the River Leven had been proposed as a possible site of a major tectonic boundary on the basis of the change in sedimentary environment (Lambert, 1975). However, the change in the nature of the metasedimentary lithologies at this junction does not mark a dramatic alteration in the original sedimentary environment. The major change is from the more-feldspathic (K-feldspar rich in thin section) Eilde Flags and their unusually coarse pebble beds into the cleaner Eilde Quartzite (plagioclase rich in thin section); however, psammites with mixtures of both feldspars occur in both the Eilde Quartzite and Eilde Schists, as well as in the Glen Coe Quartzite to the west of the GCR site, and the ‘background’ semipelite and pelite in all units remains of a consistent nature. The scale and nature of the cross-bedding and slump-folds also remains consistent across the junction.

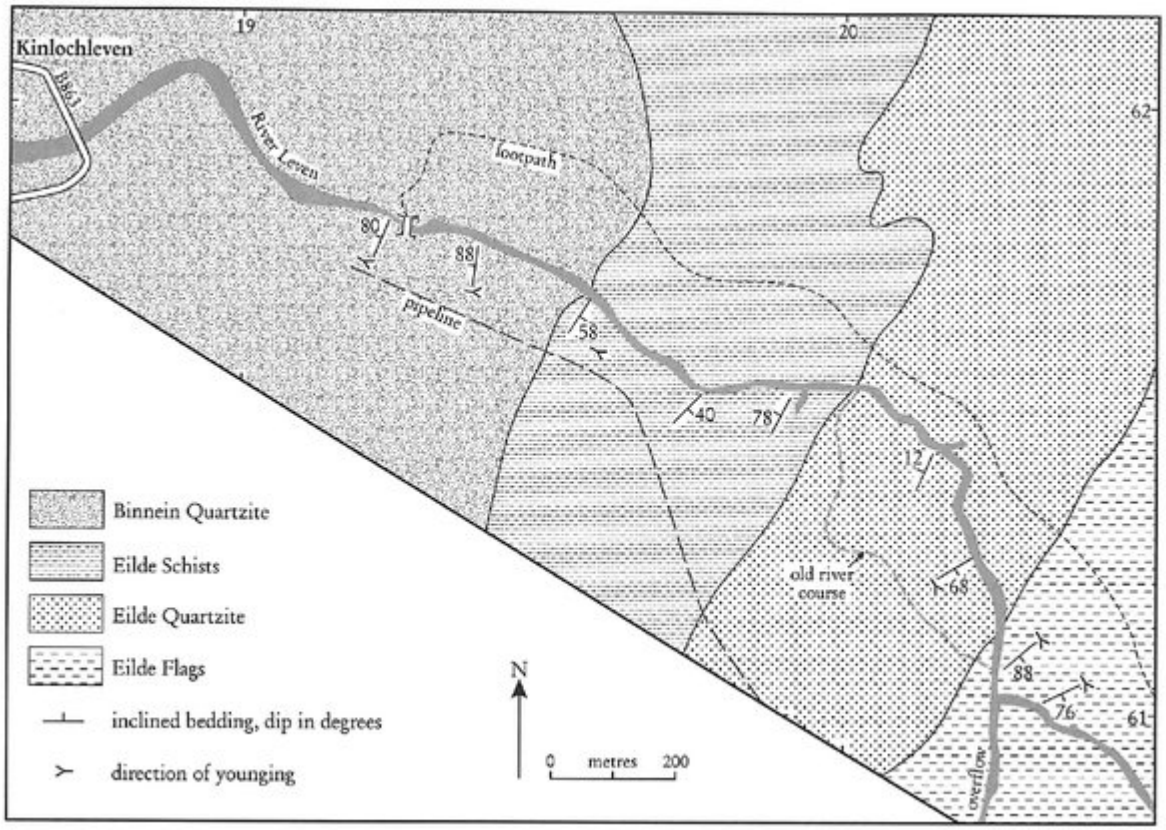
Throughout the section, the minor- and intermediate-scale folds, with their associated cleavage, consistently verge north-west in a series of step-like folds. The cleavage in the pelites is very intensely developed and might be mistaken for a first cleavage, but in thin section it is clearly a crenulation of an earlier penetrative cleavage (Treagus, 1974). In fact in some locations it is possible to see an angle between bedding and this earlier penetrative cleavage, but the plunge of their apparent intersection and their vergence relationship is so variable as to render these observations of no use in the determination of facing of the first structures. The folds and dominant cleavage belong to the regional D2 phase of Treagus (1974); the intermediate-scale folds are on the eastern limb of the major F2 Kinlochleven Anitiform (which can be seen clearly from the western part of the GCR site in the hills to the north of Kinlochleven). Minor F2 folds and cleavage on the western limb of this fold are seen in the *Nathrach* GCR site. At Nathrach, D1 structures face downwards and, according to the regional structural interpretation of Treagus (1974), the Kinlochleven Antiform would be responsible for a change in the facing of D1 structures to steeply upward-facing on its eastern limb; this facing has not been confirmed in the rocks exposed in the River Leven GCR site, but should be a subject of future research. Bailey (1960), by contrast, considered that the rocks of this GCR site lie in the hinge area of a major recumbent F1 syncline, facing towards the west, a view that was shared by Hickman (1978). In the latter view, minor F1 folds and their axial planar cleavage would be recumbent, but the minor structure evidence presented here does not conform with that interpretation.

2.4 Conclusions

The River Leven Section GCR site is of national importance in demonstrating the continuity of sedimentation and the similarity of structural features across the boundary between the Grampian and Appin groups of the Dalradian succession. It is therefore not a candidate for the location of a major break in the history of geological events in the Scottish Highlands, as had once been suggested. The site provides a unique continuous section across the topmost formation of the Grampian Group into the loweest formation of the Appin Group and is rich in structures that provide

evidence both for the sedimentary environment of these rocks and for their deformation history. The small-scale deformational structures (folds and cleavages) are important in the reconstruction of the largest-scale folds, many kilometres in length, that make up this western part of the Grampian Mountain Belt; the site will be important for further research in this respect.

References



(Figure 3.5) Map of the River Leven section east of Kinlochleven.

(Figure 3.6) Near-vertical bedding in the Binnein Quartzite, on a horizontal surface in the River Leven at [NN 1910 6186]; the cross-sets young to the west (top of photograph). Coin is 20 mm diameter. (Photo: J.E. Treagus.)