8 Onich dry river gorge and Onich shore section

[NN 025 617]–[NN 031 626] and [NN 030 614]–[NN 052 612]

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8.1 Introduction

The two adjacent GCR sites at Onich (Figure 3.17), especially the almost continuously exposed section on the north shore of Loch Leven, are important for two reasons. Firstly, the sites expose four formations of the Ballachulish Subgroup (Appin Group) in unrivalled sedimentary detail; exposures along the hill to the west of Dubh ghlac, a glacial meltwater channel north-west of Onich village, exhibit particularly striking sedimentary structures in the Appin Quartzite. Secondly, clear minor structure observations can be made across a major syncline that has not been complicated by later deformation. The syncline is the regionally important Appin Syncline, which can be traced for 50 km down the west coast of Argyll and within which the *Ardsheal Peninsula* and *Lismore Island* GCR sites also lie.

The shore section has been described in detail by Bailey (1960), Roberts (1976), Roberts and Treagus (1977b) and Treagus (1991). It is possibly the most visited section in the whole of the Grampian Terrane, attracting professional geologists, student parties and interested amateurs. It provides an example of a key part of the Dalradian succession, and is used as a mapping exercise and for demonstrating the use of minor structures to deduce the geometry of major structures.

8.2 Description

The Onich shore section provides excellent sections across all formations of the Ballachulish Subgroup, except for the Ballachulish Limestone. It is described here from east to west. The oldest formation, the Ballachulish Slates, is well seen in the steep, SE-dipping beds of a small quarry at [NN 0494 6109] to the north of the main road, as well as in shore exposures between [NN 0495 6102] and [NN 0465 6103]. This formation is typically a pyritiferous black slaty pelite with thin semipelite beds that exhibit small-scale graded bedding and cross-lamination indicating younging both to the south-east and to the north-west (for explanation, see structural detail below). Cubes of pyrite, up to 1 cm across, make the slate very distinctive and roofing slates from here, but mainly from the quarries at South Ballachulish, can be seen throughout Britain. In the Onich area, most of the pyrite has been altered to red-brown pyrrhotite, due to contact metamorphism by the Ballachulish granitic pluton, which crops out 1.5 km to the south.

The Appin Quartzite is particularly well exposed on the foreshore at [NN 0437 6105], where steep, overturned, SE-dipping beds show many examples of trough cross-bedding younging to the north-west (Figure 3.19). Unfortunately, the junction with the Ballachulish Slates to the east is not exposed and the Appin Transition Formation is not represented. Here the Appin Quartzite is white and gritty, containing pebbles of pink feldspar and creamy quartz in various concentrations. Individual clasts, only slightly deformed, are up to 2 cm in longest dimension. The shore exposures, on the east limb of the Appin Syncline, are complemented by those on the west limb in the Onich Dry River Gorge GCR site. The latter occur along the track in the valley bottom (Dubh ghlac) and on the hill to its north-west (Druim nan Sleibhean), from [NN 0242 6178] to [NN 0314 6254]. Numerous small exposures occur, particularly in a drainage ditch to the north-west of the track, exhibiting ripple marks of various dimensions and orientations on NE-striking bedding surfaces that dip at 50–75° to the south-east. The ripple marks commonly have a wavelength of some 30 cm but smaller (2–3 cm scale) structures are also seen. Most ripples have a sub-horizontal orientation, but others with a down-dip orientation or a steep pitch to the south-west or north-east can be observed locally and produce interference patterns with the former set. Most importantly, 20–30 cm-high cross-sets can be seen (e.g. by the track at [NN 0250 6180] and on the hill at [NN 0265 6200]), which clearly demonstrate that the beds are right-way-up and young to the south-east. The overall width of the

quartzite outcrop suggests that an intermediate-scale fold must occur in the unexposed ground to the east of the track, as shown in (Figure 3.18).

The Appin Limestone, which occupies most of the shore section from its faulted junction with the Appin Quartzite to [NN 0390 6126] (below the school), is a very varied member, which in this area comprises the lower part of the Appin Phyllite and Limestone Formation. For the first 150 m west of the Appin Quartite it contains much platy pink quartzite, probably repeated in folds, but typically it consists of thin beds of cream-coloured metadolostone (tens of centimetres thick) and lesser white metalimestone with local interbeds of phyllitic semipelite, pink quartzite and psammite. Small-scale graded bedding and cross-lamination in the steep SE-dipping beds are well seen near the faulted junction with the Appin Quartzite and in psammite interbeds 150 m to the west. These sedimentary structures mostly indicate younging to the south-east, so that the beds are right-way-up (for explanation, see structural detail below). A pink microdiorite dyke at [NN 0395 6125] marks the core of an anticline in metalimestone, exhibiting south-east younging on its south-east limb.

For a further 200 m, on the north-west limb of the anticline, thin metalimestones are seen in gradational contact with the upper part of the Appin Phyllite and Limestone Formation, here called the Appin Phyllite. The latter consists of grey, phyllitic semipelites containing numerous intercalations of schistose calcsilicate rock and purer metalimestone as well as flaggy quartzite. The Appin Phyllite to the west is exposed continuously between [NN 0371 6127] and [NN 0318 6129] (below the Onich Hotel). Centimetre-scale graded bedding and cross-laminations are common and these structures show consistent younging to the north-west in the overturned, steeply SE-dipping beds. SE-verging minor folds of thin metalimestones are seen from [NN 0371 6127] to the centre of the main synclinal fold, which is marked by some 50 m of younger dolomitic metalimestone at [NN 0342 6131] (Figure 3.17), (Figure 3.18). The excellent exposures at the far west end of the section, below the hotel, show the same sedimentary structures, including slump-folds, younging to the east in shallower SE-dipping beds on the *west* limb of the syncline. Isolated exposures of Appin Phyllite, Appin Limestone and Appin Quartzite are seen on the west limb, at [NN 0302 6140] (south of the road), [NN 0259 6146] and [NN 0241 6153] (north of the road), respectively.

As demonstrated above, the gross stratigraphical repetition across the site, together with change in the dip of bedding and the abundant sedimentary way-up indicators, clearly reveals the presence of a major tight syncline, with an overturned south-east limb. This is interrupted by one conspicuous intermediate-scale anticline at [NN 0393 6125] and a faulted-out syncline as described above. In addition, the shore section presents an unusual wealth of first phase (D1) minor structures (folds and cleavage/bedding relationships) that can be used to demonstrate the presence and geometry of the major syncline, the anticline and several other smaller-scale folds, which are described below from east to west (Figurs 17), (Figure 3.18).

The outcrops of the Ballachulish Slates at the east end of the shore section are too isolated to be useful in the interpretation of the major first fold geometry. However, these outcrops, do contain reversals of younging and of cleavage/bedding relationships that demonstrate the presence of intermediate-scale F1 folds. The exposures also contain a later crenulation cleavage and minor folds, which indicate that a major synform is to be expected to the east of the GCR site.

Proceeding westwards, the Appin Quartzite outcrop at the eastern end of the shore section is isolated by a fault or slide along its western margin with the Appin Limestone, marked by a few centimetres of platy schists with lens-shaped quartz-veins. The dolomitic metalimestone a few metres west of the fault contains both E- and W-verging, vertically-plunging, isoclinal folds; W-verging minor structures in the E-younging rocks for 150 m to the west show that a major- or intermediate-scale syncline must be replaced by the fault, as illustrated in the cross-section of (Figure 3.18).

On the hill to the north-east of the shore section, at [NN 4096 6175], a 10 m-thick psammitic bed within the Appin Limestone closes in the probable core of this syncline (J.L. Roberts, personal communication, 1977). The intermediate-scale anticline at [NN 0393 6125] can be identified both from exposure of its hinge and from changes in minor fold and cleavage vergence in the Appin Limestone for 100 m around the hinge area. To the west, at [NN 0375 6128], another fold-pair with a 20 m wavelength can be identified from vergence reversals in beds transitional into the Appin Phyllite.

On the foreshore, from [NN 037 613] westwards, well-developed minor structures in the Appin Phyllite consistently verge to the east, indicating that a major syncline lies to the west (Figure 3.18); the hinge of this fold can be identified in metalimestones at [NN 0338 6130]. Excellent minor structures can then be seen, verging west, away from the hinge, in the remaining 150 m of exposure. Minor folds throughout the shore section plunge on average at 10–30° to the south-west, although locally they plunge at up to 50° to the south-west and at low angles to the north-east. A penetrative phyllitic cleavage, axial planar to the minor folds, dips at 60–80° to the south-east. A down-dip stretching lineation is well seen on the cleavage planes in the phyllitic rocks, emphasized by the orientation of millimetre-long biotite crystals.

8.3 Interpretation

The Onich GCR sites provide good type examples of the lithologies and of sedimentary structures within the Ballachulish Slate and Appin Quartzite formations. The exposures of the Appin Limestone and the Appin Phyllite and their transitional junction are also unrivalled for their clarity and detail. In contrast to exposures of these two stratigraphical units farther to the south-west (e.g. at the *Arsheal Peninsula* GCR site), at Onich they exhibit considerable interleaving of phyllitic rocks, metadolostone and grey metacarbonate rock as well as of local psammites. Some of this interleaving can be attributed to tight interfolding (see below) but it did lead Bailey (1960, pp. 37–38) to abandon the distinction of the two units and in most areas they are now combined formally as the Appin Phyllite and Limestone Formation. A separate Appin Limestone Member is recognized only where it can be clearly distinguished.

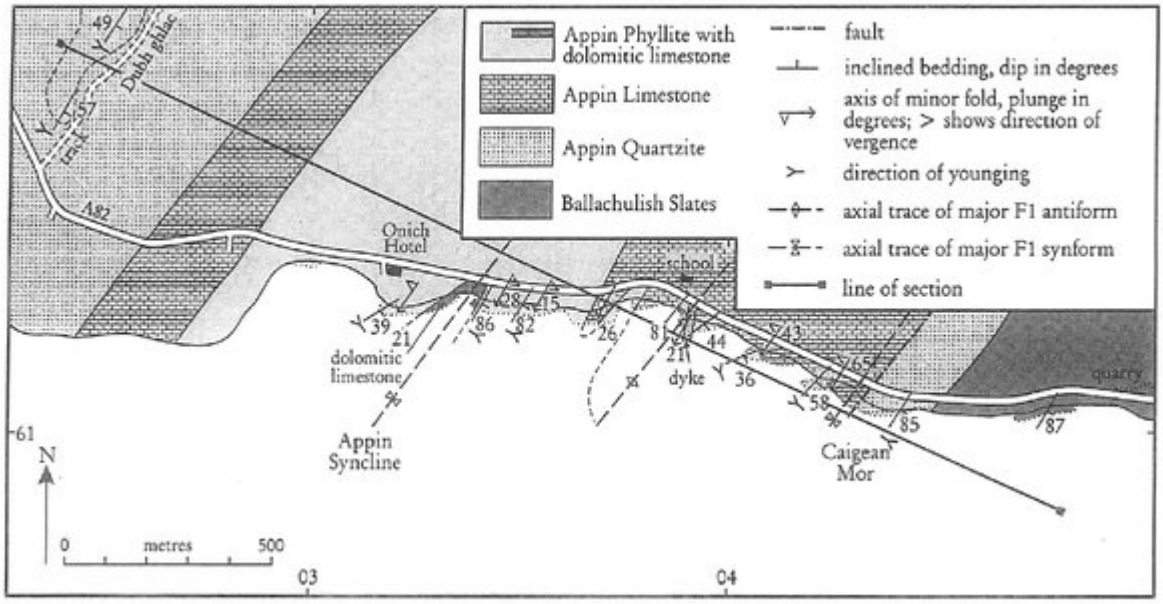
Structurally, there can be no doubt that the minor folds and cleavage are of the first regional generation (D1) and they clearly demonstrate that the major syncline, the Appin Syncline of Bailey (1960) is of this age. Although strictly this D1 age can only be demonstrated from thin section examination (Roberts, 1974; Treagus, 1991) the cleavage as viewed in the field is penetrative and the folds do not refold any earlier cleavages, lineations or folds.

It should be noted that Hickman (1978) regarded the Appin Syncline as a D2 structure, partly on regional considerations and partly from comparisons with observations on the structure farther to the south-west (see the *Ardsheal Peninsula* and *Lismore Island* GCR site reports). His explanation for the penetrative nature of his ‘S2’ slaty cleavage was that the regional first cleavage, seen in the schists to the east (see the *Rubha Cladaich* and *Nathrach* GCR site reports) has been overprinted to become unrecognizable at Onich.

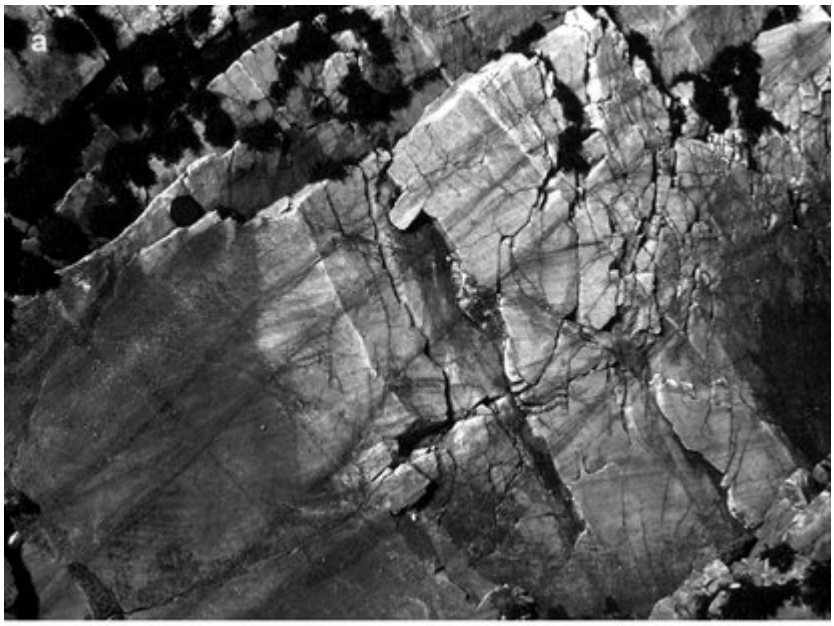
8.4 Conclusions

The two GCR sites at Onich are important for two reasons. Firstly, they contain unrivalled sections of four stratigraphical units of the Ballachulish Subgroup–the Ballachulish Slates, the Appin Quartzite, the Appin Limestone and the Appin Phyllite. These are rich in detail revealing the nature of the original sediments, particularly structures showing the original order of deposition. Secondly, they contain a wealth of minor structures (folds and cleavages) resulting from the deformation of the sedimentary rocks. The latter structures can be used to demonstrate the D1 relative age, position and shape of a major fold having an outcrop width of several kilometres. This Appin Syncline is a key component of the overall structure of the Grampian mountain belt.

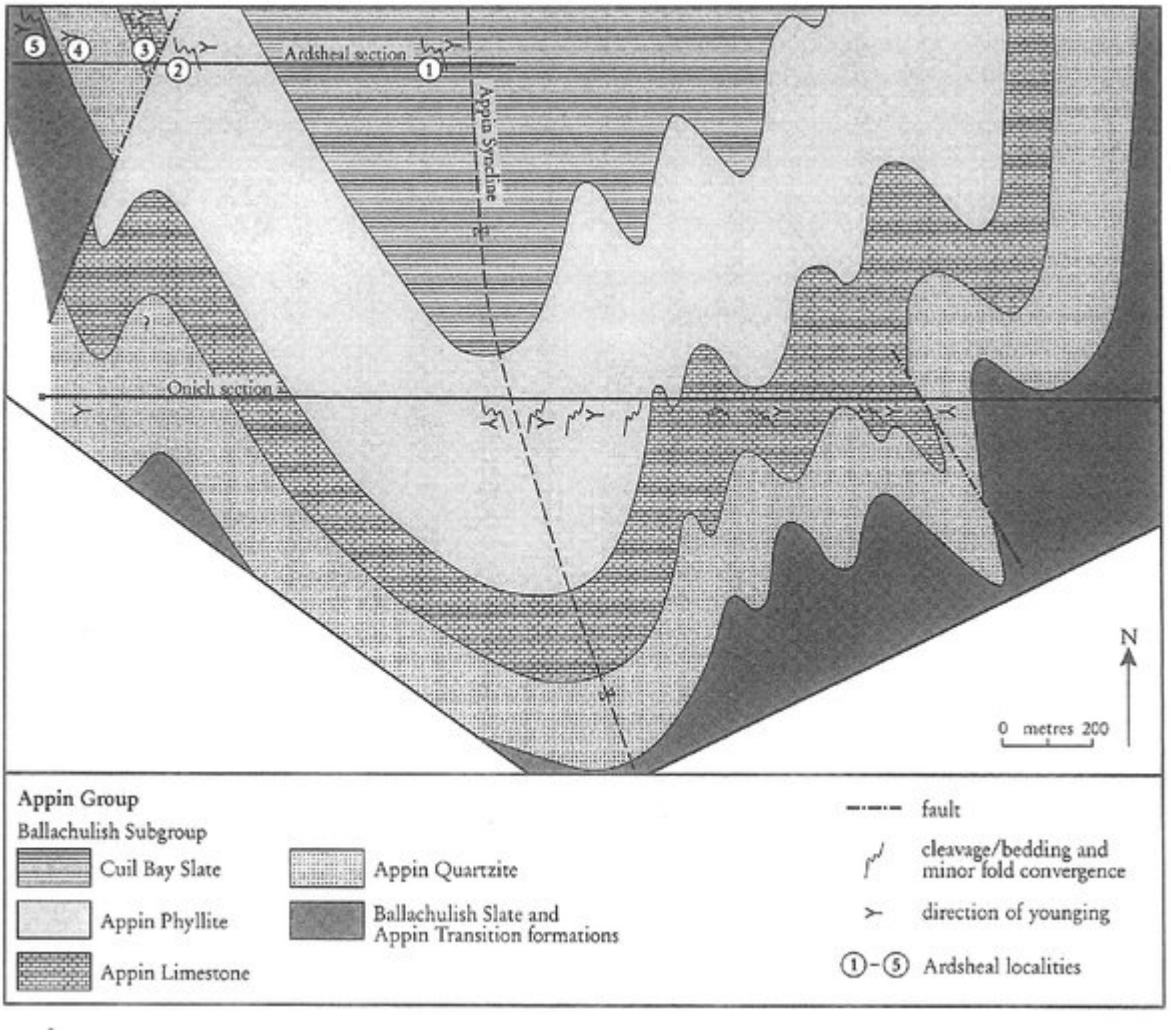
References



(Figure 3.17) Map of the Onich Shore Section and the south-west end of the Onich Dry River Gorge GCR sites. Areas outlined by dotted lines are exposures discussed in the text, showing typical measurements of bedding (with direction of younging where appropriate) and plunge (and vergence where appropriate) of F1 minor folds.



(Figure 3.19) (a) Cross-sets, younging to the north-west (top left) on a horizontal surface of near vertical-dipping Appin Quartzite at Caigean Mor [NN 0437 6105] on the Onich shore section. Lens cap (top left) is 4 cm diameter. (b) View to the north-east of SE-verging F1 folds of a 10 cm-thick limestone bed, and of thinner adjacent beds, in the Appin Phyllite on the Onich shore section at [NN 036 612], 300m SW of the school. Coin (centre) is 30 mm in diameter. (Photos: J.E. Treagus.)



(Figure 3.18) Generalized structural profile of the F1 Appin Syncline for the area containing the Onich Dry River Gorge, Onich Shore Section and Ardsheal Peninsula GCR sites, looking up-plunge to the north-east at about 25°. Use has been made of data from the Onich shore section as well as the profile drawn of the Ardsheal area by Treagus and Treagus (1971, figure 2). Data from localities 1–5 of the Ardsheal Peninsula GCR site are shown in the top left corner of the profile.