22 Kilchiaran to Ardnave Point, Islay

[NR 185 587]–[NR 298 740]

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22.1 Introduction

Isolated from the rest of the South-west Grampian Highlands by the Loch Gruinart Fault, rocks belonging to the Colonsay Group crop out in western Islay and on the islands of Oronsay and Colonsay. On Islay they form a continuous outcrop occupying the northern half of the Rhinns of Islay (Figure 2.49). This GCR site includes an almost continuous section along the west coast of the Rhinns, from Kilchiaran to Ardnave Point. Also included within this site is a coastal exposure of the meta-igneous basement rocks that form the southern part of the Rhinns of Islay. Their contact with the Colonsay Group is a zone of high strain.

The Colonsay Group was first described by Wilkinson (1907), and more recently by Stewart (1969), Stewart and Hackman (1973), Fitches and Maltman (1984), Bentley (1988) and Muir *et al*. (1995). The group is 5.5 to 6 km thick. On Islay, the lower part consists of a series of low-grade metasedimentary rocks, which are predominantly gritty metasandstones and metamudstones. These rocks have been subjected to several phases of deformation, which have resulted in a series of major upright folds trending north-east–south-west. The upper part of the group is exposed only on Oronsay and Colonsay. Stewart and Hackman (1973) proposed a tentative correlation between the upper part of the Islay succession and the lower part on Oronsay, but Bentley (1988) thought it possible that up to a kilometre of intervening strata is covered by sea between Islay and Oronsay.

None of the above authors drew any firm conclusions as to the stratigraphical correlation of the Colonsay Group with other major units in the Scottish Highlands. Stewart (1969) concluded that it could not be correlated reliably with any other stratigraphical unit, but Stewart and Hackman (1973) tentatively suggested a correlation with the Appin Group (Dalradian) of the Lochaber area. Fitches and Maltman (1984) did not rule out its correlation with the Dalradian, but they did have reservations on structural criteria. Bentley (1988) suggested that the Colonsay Group–Appin Group correlation is unlikely on geochronological grounds (see below). He also ruled out a correlation with the Torridonian on structural and tectonic criteria, and with the Moine Supergroup on geochronological grounds, but proposed a tentative correlation with the Iona Group.

The basement rocks of the Rhinns Complex (Muir, 1990; Muir *et al*., 1994a), are now known to be younger than was thought by early workers such as Wilkinson (1907), who assumed that this series of amphibolite-facies metagabbros and metasyenites were part of the Lewisian Gneiss Complex. Subsequent investigations have yielded an age of 1782 +/- 5 Ma (Marcantonio *et al.*, 1988), and although this correlates well with the tectonothermal reworking of the Lewisian during the Laxfordian Event (Mendum *et al*., 2009), stable isotopes indicate that the gneisses of the Rhinns Complex are derived dominantly from juvenile mantle material, which is not known to be associated with the Laxfordian Event. Consequently they are now believed to be part of an extensive Palaeoproterozoic orogenic province in the North Atlantic region (Dickin, 1992; Muir *et al*., 1992). They cannot therefore be correlated with any other rock units in Scotland. They are too old to be Moine or metamorphosed Torridonian and they are too young to be Lewisian.

22.2 Description

The basement rocks of the Rhinns Complex are not particularly well exposed, and the best exposures occur on the west coast of the Rhinns. They consist predominantly of metagabbros and metasyenites, interpreted as an alkaline igneous complex that has been subjected to multiphase deformation and amphibolite-facies metamorphism (Muir *et al.,* 1992).

The metasyenite is well exposed along the coast where it appears as a pink feldspathic foliated rock, with thin schistose amphibolite sheets; good examples of these may be found about 1.5 km south-west of Kilchiaran at [NR 185 591]. Towards the boundary with the overlying Colonsay Group the fabric intensifies, becoming mylonitic at the boundary (the Kilchiaran Shear-zone or Bruichladdich Slide). The position of the boundary is easily identified by the distinct change in lithology from the sheared feldspathic gneiss to a gritty metasandstone (the Eilean Liath Grit), with an intense mylonitic fabric. For the most part, the actual contact between the two lithologies is not exposed but lies within a deeply eroded gully. However, at [NR 1878 5933], 1 km south-west of Kilchiaran, the contact is exposed at low tide (Figure 2.50). At this locality the shear-zone strikes at *c.* 040°, but the strike varies inland due to folding (see (Figure 2.49)).

The Colonsay Group on Islay was mapped by Stewart and Hackman (1973), who identified ten formations that are essentially a series of gritty metasandstones, metamudstones and metagreywackes (Table 1). They described the Eilean Liath Grit, the Rubha Gàidhealach Grit and the Crosprig Grit as coarse feldspathic sandstones. Cross-bedding was identified in both the Rubha Gàidhealach Grit and the Crosprig Grit, and conglomeratic facies with pebbles up to 4 cm in size were recognized in the Crosprig Grit.

There is good exposure of the Eilean Liath Grit along the coast south-west of Kilchiaran and the overlying Kilchiaran Phyllite is well exposed at Kilchiaran Bay [NR 201 599]. The phyllite is a mudstone with thin silty bands, which has been deformed and metamorphosed and now has a strong slaty cleavage. A thin bed of possible volcaniclastic origin has been identified near the top of the formation by Batchelor (2011). The overlying formation is the Rubha Gàidhealach Grit, which is exposed on the headland at [NR 198 601]. The overlying Rubha na h-Àirde Mòire Phyllite is fine grained at the base where the cleaved metamudstone has been quarried for slate; however, it grades upwards into flaggy fine-grained metasandstones. These are exposed around the headland of Rubha na h-Áirde Mòire (Figure 2.49) where they occupy the core of a large, kilometre-scale syncline. Above the Rubha na h-Àirde Mòire Phyllite are the Cosprig Grit and the Kilchoman Phyllite. The Kilchoman Phyllite consists of grey metamudstones with calcareous bands; graded beds have been observed in this unit (Stewart and Hackman, 1973). Muir *et al.* (1995) re-examined these rocks and concluded that the Crosprig Grit and the Kilchoman Phyllite are not separate formations but are simply the Rubha Gàidhealach Grit and the Kilchiaran Phyllite repeated by upright folding (Table 1).

They did not, however, re-examine the upper four formations; these were described by Stewart and Hackman only. The Smaull Greywacke consists of a sequence of graded metagreywacke units, some of which are be quite coarse grained, with grain sizes of up to 2–3 mm. This grades upwards into the Sanaigmore Phyllite, which is a dark-grey metamudstone with silty calcareous bands. Above this, is the Sanaig Greywacke, which consists of graded metagreywacke. The youngest Colonsay Group formation on Islay is the Ardnave Formation, which consists of a thick sequence of metamudstones and fine-grained laminated metagreywackes.

The structure of the Colonsay Group was described in detail by Fitches and Maltman (1984). They identified four stages of deformation on both Islay and Colonsay, which they numbered D1 to D4; these numbers relate to the Colonsay Group only. The first phase, D1, is a grain-alignment fabric, which is sub-parallel to bedding. D2 is expressed by a strong stretching lineation developed in metasandstones, and by close to isoclinal, recumbent to reclined minor sheath folds. These folds have axial planar crenulation and pressure-solution cleavages. D3 is the phase of deformation that produced most of the mapped folds. These are fairly upright, gently NE-plunging folds with wavelengths up to several hundred metres, and axial planar crenulation cleavages. D4 is represented by chevron folds and kink bands, and associated crenulation cleavages. The axial planes to D4 folds are upright and strike east–west.

On Islay the dominant phase of deformation is D3; all the folds shown on (Figure 2.49) are F3 folds. Minor structures of more than one generation can be observed in most exposures of phyllitic rock, for example, two crenulation cleavages, one steep and the other flat lying, are present in the Kilchiaran Phyllite near Kilchiaran. Minor folds are ubiquitous in the coarser grained horizons.

Two thin lamprophyre dykes intrude the Kilchiaran Phyllite at Kilchiaran Bay; these have a tectonic fabric and consequently they were intruded at least prior to some of the deformation.

Associated with this deformation is low-grade metamorphism. Chlorite, white mica, and rare biotite have been identified in Colonsay Group rocks (Fitches and Maltman, 1984), indicating that the rocks were subjected to greenschist-facies metamorphism.

Table 2.1 Stratigraphical sequences for the lower part of the Colonsay Group according to Stewart and Hackman (1973) and Muir *et al.* (1995).

Stewart and Hackman (1973)	**Muir *et al.* (1995)**
Kilchoman Phyllite	(Rubha na h-Airde Móire Phyllite -repeated through folding)
Crosprig Grit	(Rubha Gaidhealach Grit- repeated through folding)
Rubha na h-Airde Móire Phyllite	Rubha na h-Airde Móire Phyllite
Rubha Gaidhealach Grit	Rubha Gaidhealach Grit
Kilchiaran Phyllite	Kilchiaran Phyllite
Eilean Liath Grit	Eilean Liath Grit

22.3 Interpretation

It is now generally accepted that the basement to the Colonsay Group, namely the Rhinns Complex, is not Lewisian but is Palaeoproterozoic. There are no rocks of comparable age in Scotland, but rocks similar in age *and* lithology are found on Inishtrahull off the north coast of Ireland (Muir *et al*., 1992). It is possible that the Rhinns Complex is a unique terrane in the British Isles, and may possibly be linked to the Ketilidian Belt of south Greenland (Stone *et al.,* 1999). Alternatively, it is possible that it forms the basement to the Dalradian Supergroup over much of its outcrop. Much, therefore, depends on the tectonic significance of the Loch Gruinart Fault, which is not exposed.

Although the nature of the contact between the Rhinns Complex and the Colonsay Group is tectonic (the Kilchiaran Shear-zone or Bruichladdich Slide), the Colonsay Group almost certainly forms the cover to the Rhinns Complex basement. The contact shear-zone was interpreted as a sheared unconformity by Wilkinson (1907) and subsequently by Bentley (1988), on account of the presence of a ‘basal conglomerate’ close to the boundary. However, Stewart and Hackman (1973) disputed this, as they did not detect any facies changes close to the shear-zone, and observed that the five lowest units of the Colonsay Group are truncated against the basement. They therefore interpreted the contact as a zone of high strain and a tectonic break, which they referred to as the Bruichladdich Slide. Muir *et al*. (1995) suggested that the contact is somewhat more complex than the term ‘slide’ implies, involving tectonic interleaving of Colonsay Group and basement rocks, and renamed it the Kilchiaran Shear-zone. The Kilchiaran Shear-zone/Bruichladdich Slide is folded around F3 folds and hence is either a D1 or D2 structure.

The lowest 800 m of the Colonsay Group succession on Islay has been interpreted as representing delta-top sheet sands and interdistributary muds, whereas the upper part suggests deeper water, delta-slope turbidites. The sediments were derived from the west, from a hinterland of deformed high-grade gneisses with a sedimentary cover (Stewart and Hackman, 1973). Saha (1985) pointed out that the source area could not have been very distant, as the feldspar clasts are angular and fresh. The presence of clasts of blue quartz has been taken to suggest granulite-facies rocks, although the local Rhinns Complex basement is neither granulite facies nor contains blue quartz; a more likely source would be the Lewisian Gneiss Complex of the Hebridean Terrane.

Correlation of the Colonsay Group with other Highland rocks would greatly aid interpretation of the significance of the Loch Gruinart Fault, and the relationship of this west Islay terrane with other Highland terranes. For example, if the Colonsay Group should prove to be an integral part of the Dalradian Supergroup, then the Loch Gruinart Fault would not be a terrane boundary, and the Rhinns Complex could form the basement to the Dalradian elsewhere. However, the earlier, D1 and D2 structures in the Colonsay Group, which are also present in the Rhinns Complex, have no obvious counterparts in the Dalradian of eastern Islay or in the South-west Grampian Highlands; it is the later D3 and D4 structures that can be correlated most readily with those of the Islay Anticline (Fitches and Maltman, 1984; Bentley, 1988). Hence, the Colonsay Group does not appear to have the same tectonic history as the Dalradian. This would imply that the west Islay terrane is unrelated to other terranes in Scotland. Indeed Rogers *et al.* (1989) suggested that it was the docking of this terrane with the Grampian Terrane that initiated the tectonic activity in the Dalradian rocks that is

generally referred to as the Grampian Event.

Establishing an age for the Colonsay Group has proved elusive. Bentley (1988) dated some appinitic intrusions on Colonsay, which he interpreted as post-dating the early deformation and pre-dating the late deformation. From $^{40}Ar/^{39}Ar$ stepwise heating methods on hornblende, he suggested that the best estimate of the age of these intrusions is *c*. 600 Ma. This implied that the Colonsay Group is older than 600 Ma, as is some of the deformation that has affected it. However, this date is now believed to be a result of excess argon, and a U-Pb date of 439 ± 9 Ma, derived from zircons in one of the intrusions by ion-microprobe (SHRIMP) is currently accepted as the crystallization age (Muir *et al*., 1997). Furthermore, the intrusion is now considered to have been emplaced after all main phases of deformation and hence the Colonsay Group and its deformation pre-date *c*. 440 Ma. This does strengthen the case for correlating the Colonsay Group with part of the Dalradian, although the difficulties in matching their detailed structural histories remains a problem.

The Colonsay Group is currently interpreted as a sequence of low-grade metasedimentary rocks that were deposited sometime in the Neoproterozoic. These rocks were laid unconformably on a Palaeoproterozoic basement in an intracratonic basin setting, and were possibly deformed during a Neoproterozoic orogenic event(s) that is not recognized in Dalradian rocks. However, recent research suggests that tectonism could have affected at least part of the Dalradian prior to the Grampian Event (Tanner and Bluck, 1999). Hence it may yet be shown that the Colonsay Group does indeed have structural and stratigraphical affinities with the Dalradian rocks of the central Grampian Highlands and this interpretation has been strengthened by U-Pb ages of detrital zircons, which are comparable with the Grampian Group (McAteer *et al*., 2010).

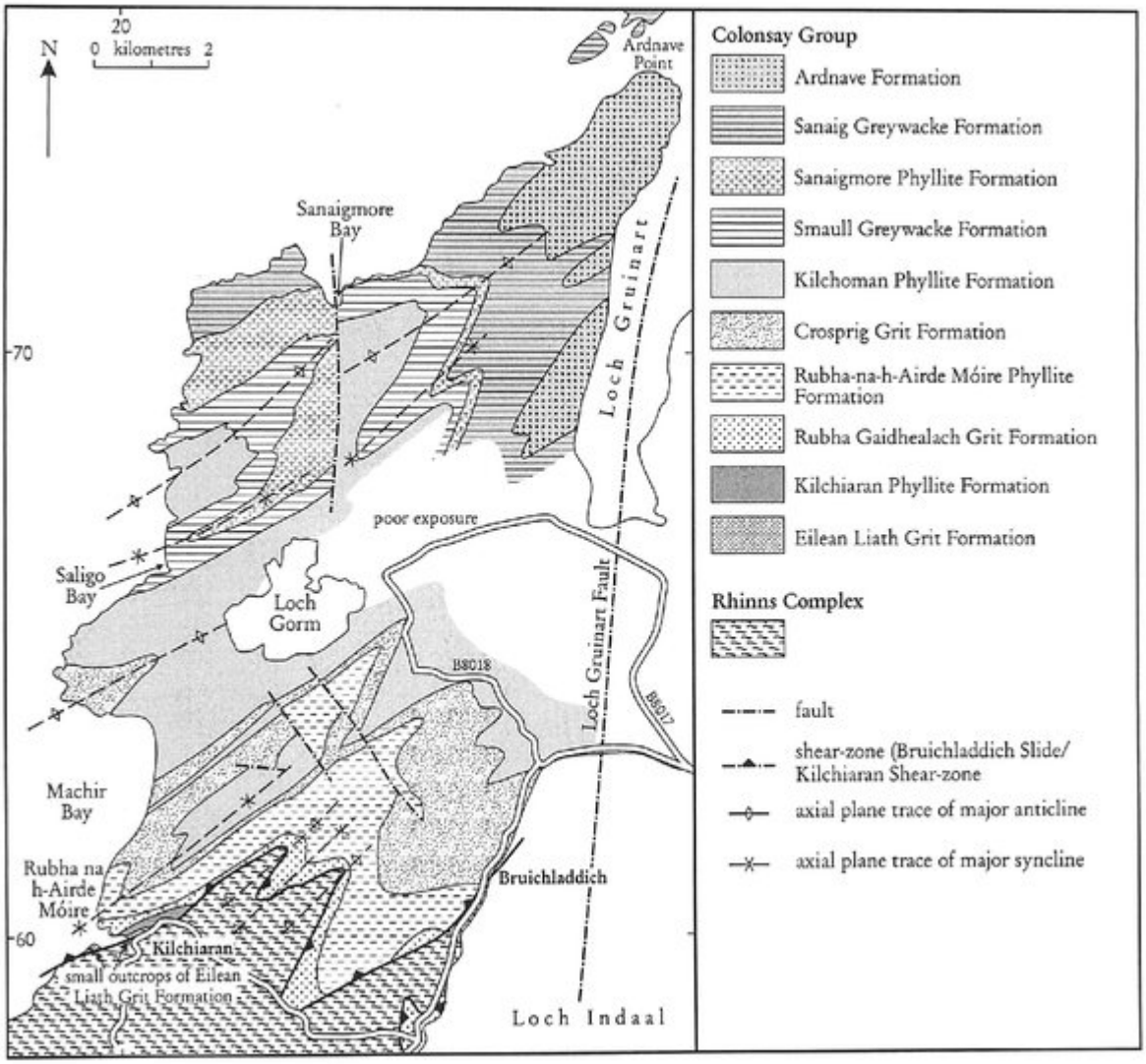
22.4 Conclusions

The continuous section from Kilchiaran to Ardnave Point, on the north-western coast of the Rhinns of Islay, provides excellent exposures of the lower part of the Colonsay Group, arguably the most enigmatic sequence of metasedimentary rocks in the Grampian Terrane. Its stratigraphical affinities are uncertain; the most obvious lithological correlations are with the Grampian Group and lowest Appin Group of the Dalradian. However, rocks of the Colonsay Group record four distinct phases of deformation, including an early event that cannot be recognized in undoubted Dalradian rocks nearby, suggesting that they might belong to a separate west Islay terrane, having a different tectonic history to the main Dalradian outcrop.

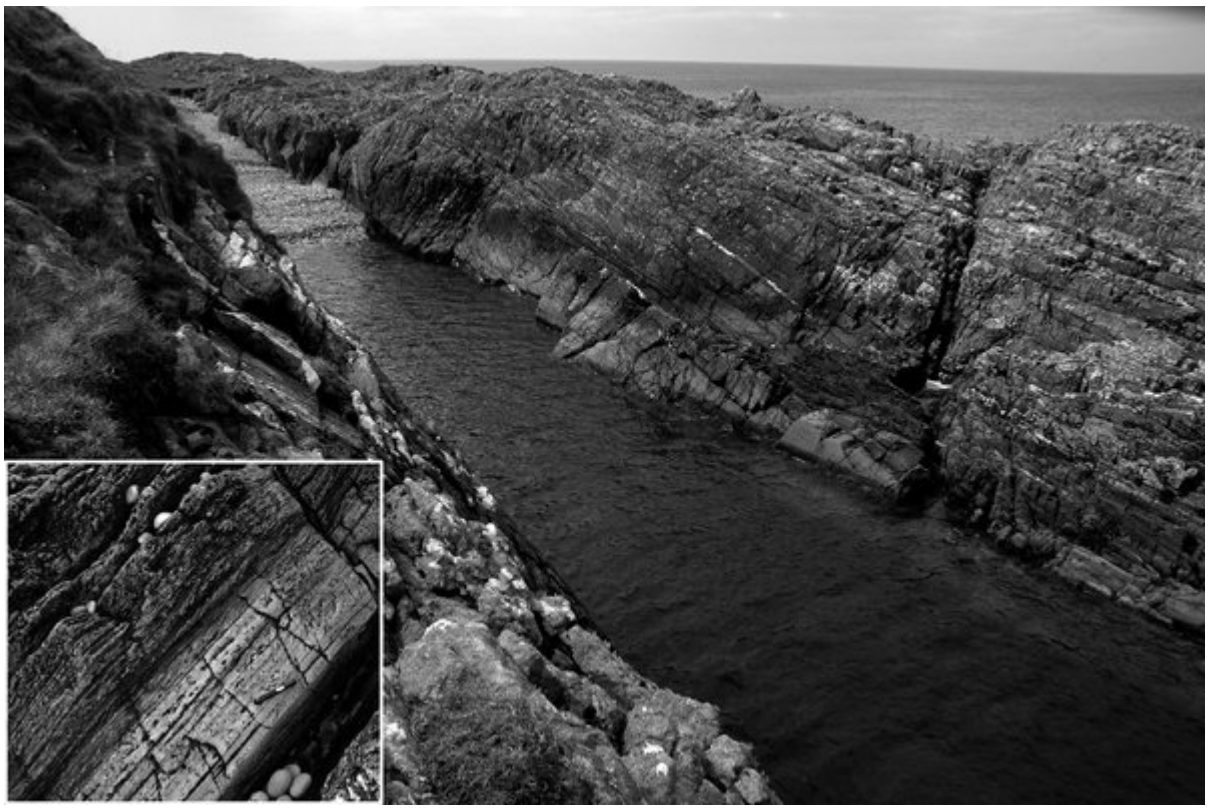
The contact of the group with meta-igneous basement rocks of Palaeoproterozoic age is also exposed at this GCR site. The contact is sheared and mylonitic in places and the original relationship between the Colonsay Group and the Rhinns Complex, which is like no other basement in Scotland, has been a matter of some debate.

The age of the Colonsay Group and its relationship to its Palaeoproterozoic basement have profound implications for the identification of the diverse geological terranes that came together during the Caledonian Orogeny to form the Scottish Highlands. Hence, they might provide a vital link in understanding the complex inter-relationships between the Neoproterozoic rocks of North America, Greenland and north-west Europe, and are potentially of international importance.

References



(Figure 2.49) Map of north-western Islay showing outcrops of the Colonsay Group and its basement of Rhinns Complex, modified after Stewart and Hackman (1973) and Muir et al. (1995).



(Figure 2.50) Topographical expression of basement–cover contact c. 1 km south-west of Kilchiaran Bay, north-west Islay. Gritty metasandstones of the Eilean Liath Grit Formation of the Colonsay Group to the right of the inlet are separated from highly sheared feldspathic gneisses of the Rhinns Complex to the left by the Kilchiaran Shear-zone, which controls the line of the inlet. Inset shows the strongly sheared rocks in the contact zone; spirit level is 5 cm long. (Photos: P.W.G. Tanner.)