
19 South Bay, Barmore Island

[NR 868 714]–[NR 872 702]

J.L. Roberts and P.W.G. Tanner

Published in: The Dalradian rocks of the south-west Grampian Highlands of Scotland. PGA 124 (1–2) 2013.

<https://doi.org/10.1016/j.pgeola.2012.07.008>. Also on [NORA](#)

19.1 Introduction

Barmore Island is situated a few kilometres north of Tarbert, on the east side of the Kintyre peninsula. It is connected to the mainland by a narrow isthmus (Figure 2.43). The coast immediately south of the isthmus provides a well-exposed and unique cross-section through the Dalradian rocks of Knapdale and North Kintyre, which includes the critical contact between the Argyll and Southern Highland groups. This rugged coastline also displays the effects of glacial scouring by Pleistocene ice-sheets, flowing southwards along Loch Fyne.

The sequence begins with the Stonefield Schist Formation that lies at the top of the Crinan Subgroup and appears to be conformable with the overlying Loch Tay Limestone Formation, which here represents the Tayvallich Subgroup. Towards the south-east, these rocks pass stratigraphically upwards, with no discernable break, into the Southern Highland Group, which comprises the Glen Sluan Schist Formation, the Green Beds Formation, and the Beinn Bheula Schist Formation. The Loch Tay Limestone forms one of the most important marker horizons for lithostratigraphical correlation within the Dalradian Supergroup. It is equivalent to the Tayvallich Slate and Limestone Formation, which lies in the core of the Loch Awe Syncline farther to the north-west.

This GCR site lies adjacent to the major F4 Tarbert Monoform, which separates the Knapdale Steep Belt to the north-west from the inverted rocks of the Cowal Antiform to the south-east. This setting is comparable with that of the *Portincaple* GCR site (Tanner et al., 2013b), which is located on the closure of the Highland Border Downbend (F4) between the Cowal Antiform and the Highland Border Steep Belt. The regional metamorphic grade reached by the rocks in the two areas is however different: those at Portincaple are barely in the biotite zone, whereas those at Barmore Island are in the garnet zone. A detailed structural analysis has not been made of the rocks of this site and they warrant further study.

Following descriptions of the general geology by the Geological Survey (Peach *et al.*, 1911) and by McCallien (1925), some of the structural features were described by Roberts (1966b, 1974, 1977c). A notable early study of the origin of the 'green beds' was carried out by Phillips (1930), and the petrography of the Loch Tay Limestone has been investigated in considerable detail by Gower (1973) and Graham *et al.* (1983).

19.2 Description

19.2.1 Stratigraphy

The Stonefield Schists occur at [NR 806 714] as garnetiferous mica schists, interbedded with quartz-mica schist and schistose gritty metasandstone. The bedding is approximately vertical and strikes north-east, with graded bedding in one exposure showing that the sequence youngs to the south-east. A transition zone some 6 m wide separates the Stonefield Schists from the Loch Tay Limestone. Within this transition zone, thin, weathered, calcareous bands appear, become thicker up-sequence and are replaced progressively by beds of dark-grey sugary metalimestone (up to 7 cm thick) separated by thin beds of dark metametamudstone.

The Loch Tay Limestone is about 75 m thick in this section, and occurs typically as a grey crystalline metalimestone (containing some dolomite) with a granular texture, interbedded with minor amounts of dark schistose metamudstone. It

has a banded appearance due to differential weathering of the centimetre-scale layers, some of which are slightly more micaceous, whereas others are more quartzose. Graded bedding in the more-quartzose layers is revealed by the transition from a quartz-rich metalimestone at the base of the bed to an increasingly carbonate-rich rock at the top. Such grading shows younging to the south-east, so the beds are inverted. A carbonate metabreccia, in which highly deformed fragments of metalimestone are flattened in a plane parallel to the steep bedding and stretched down dip, is developed close to the south-east margin of the formation. Pinch-and-swell structure commonly affects the more-quartzose layers, as well as quartz-plagioclase veins (Figure 2.44). The metalimestone is affected by a system of linked, listric faults associated with thick bodies of haematite-stained fault breccia. Two thick sills of basic meta-igneous rock, now garnet-biotite amphibolite, occur within the outcrop of the Loch Tay Limestone.

The Glen Sluan Schist Formation is exposed immediately to the south-east of the Loch Tay Limestone at [NR 868 710]. There is a sharp contact between orange-weathering metacarbonate rock and the stratigraphically younger micaceous schist, which contains numerous thick quartz lenses. The Glen Sluan Schists consist largely of quartzose mica schist, which is interbedded with minor amounts of schistose pebbly metasandstone towards its contact with the Green Beds Formation. Albite is commonly developed as conspicuous porphyroblasts in the more-pelitic layers, and can be distinguished from detrital feldspar in the more-psammitic layers by the fact that the porphyroblasts appear undeformed in hand specimen.

Individual 'green beds' occur within the succession from the Glen Sluan Schist Formation at [NR 869 710] to the Beinn Bheula Schist Formation south of Sgeir Port a' Ghuail (Figure 2.43). Where they form a dominant proportion of the succession, they define the Green Beds Formation. They occur typically as massive chlorite-epidote-biotite schists, interbedded with epidotic metaconglomerates, quartz-mica schists, and albite schists. The bedding in the 'green beds' is defined by very regular, parallel-sided, alternating fine- and coarse-grained layers, which vary in colour from green to dark greenish grey, commonly with a speckled appearance (possibly due to biotite). The layers vary in thickness from 1–20 cm and their distinctive greenish colour is due to the presence of chlorite and epidote. Locally, individual beds pass downwards into metaconglomerate (schistose pebbly grit) with detrital grains of quartz and feldspar. Graded bedding and small-scale channelling are well developed locally in schistose gritty metasandstones interbedded with the green-coloured beds. They show overall younging towards the south-east, but some beds clearly young in the opposite direction, suggesting that early (F1) folds are present in the section.

The Green Beds Formation passes upwards into the Beinn Bheula Schist Formation, which is exposed at the south-east end of the section. The latter consists of a very thick sequence of garnetiferous mica schists, biotite schists, quartz-mica schists, albite schists, and schistose gritty metasandstones containing detrital grains of quartz, often of a bluish hue, together with pink or white oligoclase feldspar.

19.2.2 Structure

The rocks at this GCR site were deformed during the D1–D4 phases of Caledonian deformation. No F1 folds have been observed but there is an early schistosity (S1), lying subparallel to bedding. Locally, both bedding and S1 are deformed by tight F2 folds, giving rise to 'strain-bands' (Clough, in Gunn *et al.*, 1897) and minor folds that plunge steeply north-east and verge towards the north-west. Typically, the F2 folds have an intense cleavage developed parallel to their axial planes, which affects the earlier S1 schistosity. The 'strain-bands', or S2 spaced cleavage domains as they are now known, are typically developed in the schistose gritty metasandstones.

L3 linear structures trend north-east, and are generally horizontal, but there is a 500 m-wide zone between [NR 871 705] and [NR 872 700] where these F3 fold hinges plunge more steeply towards the north-north-east. F4 folding affects the rocks to the south-east of the Loch Tay Limestone, giving rise to alternating zones of steeply dipping and flat-lying rocks. Typically the F4 folds have axial planes dipping at a moderately steep angle towards the south-east, parallel to a crenulation cleavage, while their fold hinges plunge at less than 10° to the north-east.

19.3 Interpretation

Stratigraphically, the Loch Tay Limestone can be correlated with the Tayvallich Slate and Limestone Formation, which crops out in the core of the Loch Awe Syncline, farther to the north-west (see the *West Tayvallich Peninsula* GCR site report; (Figure 2.34)). These formations mark a change in sedimentation from the pebbly quartzites and pebble metaconglomerates, typical of the upper parts of the Argyll Group, into the pebbly metagreywackes of the overlying Southern Highland Group. Such a change in lithology is not accompanied by any corresponding change in the mode of deposition, since graded bedding is a characteristic feature of this part of the Dalradian sequence, both above and below the Loch Tay Limestone. Thus, there is no sedimentological evidence for a profound break in the succession, or orogenic unconformity, between the Argyll Group and the Southern Highland Group.

The Green Beds Formation occurs at the same stratigraphical level as the Loch Avich Lavas Formation, which crops out farther to the north-west within the Loch Awe Syncline (see the *Loch Avich* GCR site report). The 'green beds' occur as finely laminated rocks, passing imperceptibly into graded beds of schistose gritty metasandstone, suggesting that they were deposited by turbidity currents. Their composition suggests a volcanic origin and J.B. Hill (in Peach *et al.*, 1911) suggested that they were derived from the weathering of basic igneous rocks. Their volcanoclastic origin has been confirmed by the regional petrographical and geochemical study of Pickett *et al.* (2006).

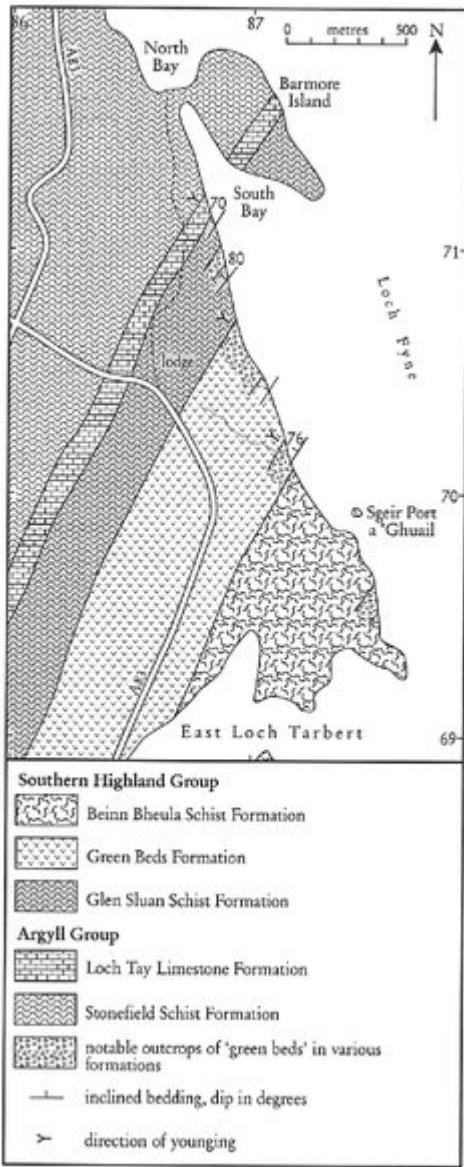
The GCR site lies on the steep, NW-dipping, overturned, south-eastern limb of the major, upward-facing F1 Ardrishaig Anticline and forms part of the Knapdale Steep Belt. The S2 spaced cleavage and minor folds verge to the north-west as a 'symmetry-constant continuation' of the earlier D1 deformation, here represented only by an S1 schistosity (Voll, 1960; Roberts, 1974). In a short distance to the south-east, the inverted beds become less steeply inclined as the Ardrishaig Anticline is folded over the broad F4 Cowal Antiform, and the minor F4 folds and SE-dipping S4 crenulation cleavage seen at this site are related to the Tarbert Monoform, a major F4 structure developed on the north-western limb of the Cowal Antiform.

19.4 Conclusions

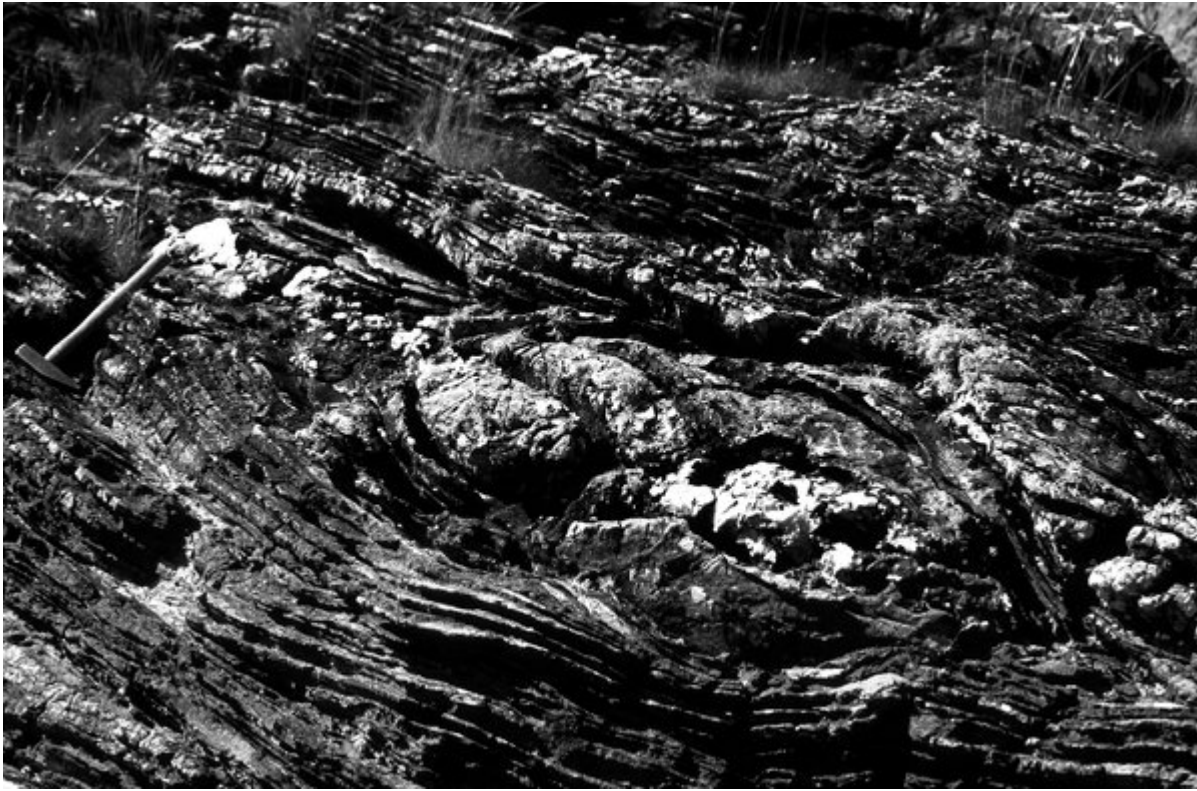
The South Bay, Barmore Island GCR site provides a representative cross-section through the Dalradian rocks of the uppermost Argyll Group and the Southern Highland Group in Knapdale and North Kintyre. The exposures show clearly that the contact between the two groups is conformable, with no evidence of a structural break, or orogenic unconformity.

The Loch Tay Limestone Formation is exposed over the full width of its outcrop, allowing it to be compared with its stratigraphical equivalent to the north-west, namely the Tayvallich Slate and Limestone Formation. The site also provides an excellent section through the Green Beds, which are otherwise poorly exposed in the South-west Grampian Highlands. Their composition and finely-laminated nature suggests that they were originally volcanoclastic deposits, which were subsequently reworked by turbidity currents. They may be correlated with pillow lavas at Loch Avich, to the north-west. This GCR site also provides typical examples of the structural features that developed in response to three distinct phases (D1, D2 and D4) in the deformation history of the Dalradian rocks in the South-west Grampian Highlands.

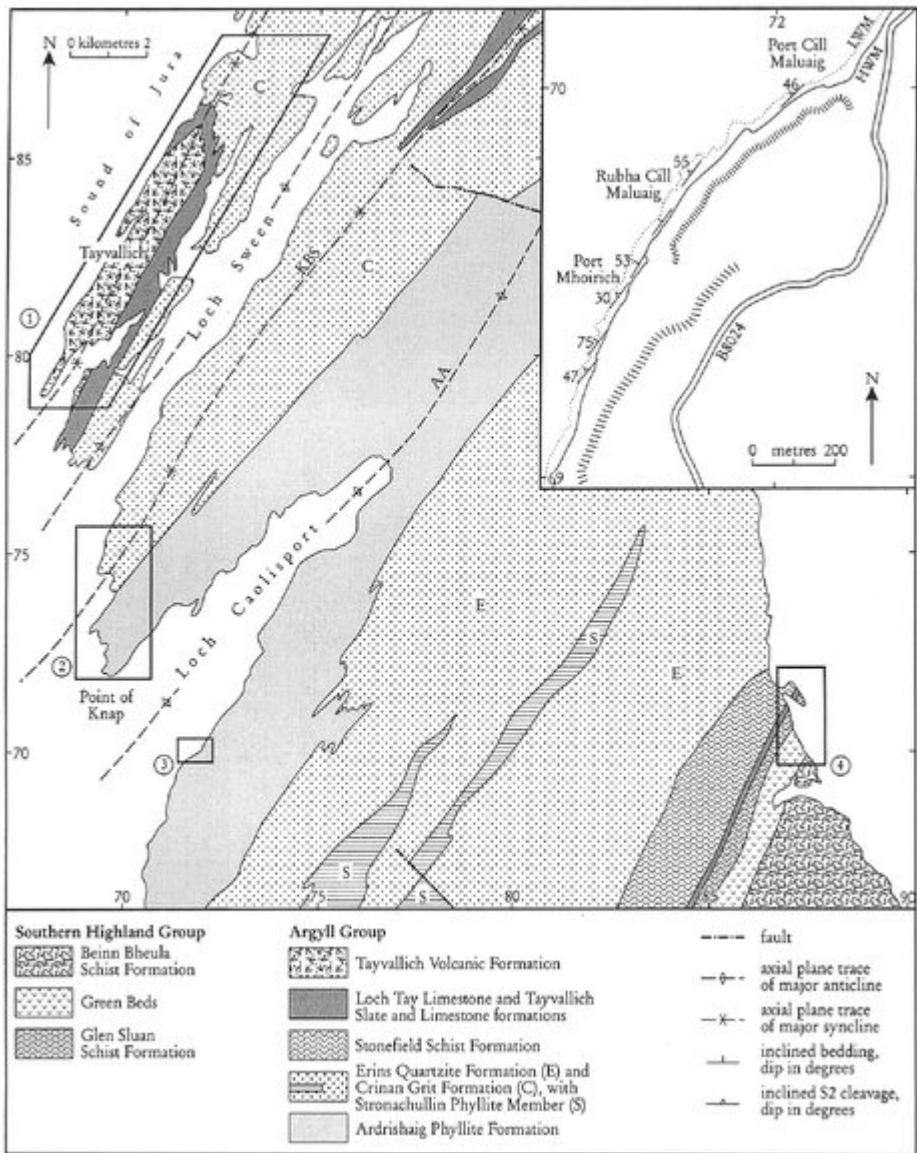
[References](#)



(Figure 2.43) Map of the coastal section between Barmore Island, Loch Fyne and East Loch Tarbert; outcrops of basic meta-igneous rock omitted (after Roberts, 1977c, with additional data).



(Figure 2.44) Typical Loch Tay Limestone lithology of thinly bedded metalimestone interbedded with dark grey metamudstone. A strongly boudinaged quartzofeldspathic vein occupies the centre of the photograph. [NR 8683 7123], South Bay, Barmore Island. Hammer shaft is 60 cm long. (Photo: P.W.G. Tanner.)



(Figure 2.34) Map of Knapdale and north Kintyre (based on Roberts, 1977c), showing outcrops of the main Dalradian units and locations of GCR sites: 1 West Tayvallich Peninsula, 2 Kilmory Bay, 3 Port Cill Maluaig, 4 South Bay, Barmore Island. AA Ardrishaig Anticline, KBS Kilmory Bay Syncline, TS Tayvallich Syncline. Inset shows the geology of the Port Cill Maluaig GCR site (3).