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# Excursion 3 Rockcliffe To Gutcher's Isle: Criffell Granodiorite, Silurian and Carboniferous stratigraphy, structure of the Solway Basin margin

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OS 1:50 000 Sheet 84 Dumfries, Castle Douglas & surrounding area

BGS 1:50 000 Sheet 5E Dalbeattie

Route map: (Figure 18)

**Main points of interest** Criffell–Dalbeattie Granodioritic complex; Ross Formation greywacke turbidites; Lower Palaeozoic structure; North Solway Fault; Lower Carboniferous basin-margin stratigraphy with conglomerates, sandstones, siltstones, marine fossils.

**Logistics** A large car park suitable for cars and coaches is situated on the left side of the road leading from the A710 to Rockcliffe village, near the top of a short steep hill [NX 851 536]. A short walk from here on the road around Rockcliffe Bay leads to public conveniences at the north side of the bay, near Port Donnel [NX 848 538]. If the excursion between Rockcliffe and Gutcher's Isle (Localities 1–4, (Figure 18)) is to be attempted as a round trip the total return walking distance is approximately 6 km, partly on coastal paths and partly over shore sections where the rocks can be wet and slippery. From Gutcher's Isle the excursion can be extended using the coastal path to Port o' Warren and Portling Bay (Locality 5). There is no parking space at these places so arrangements should be made for transport to be available at the junction of the single track Port o' Warren road and the A710 (Figure 19). Total walking distance from Gutcher's Isle to the A710 junction is 3 km. Walking boots are the best footwear for the excursion. Although some of the localities can be inspected when the tide is in, the Carboniferous rocks on the shore at Castlehill and Gutcher's Isle can be seen only at low tide.

## Introduction

During a day's excursion many aspects of Southern Uplands geology can be seen in the well-exposed coast sections around Rockcliffe on the Solway shore. North of Rockcliffe there are good outcrops of the granodiorite margin of the Criffell–Dalbeattie plutonic complex (Phillips, 1956). These lie near the steeply dipping contact between the pluton and hornfelsed Lower Palaeozoic strata of the Ross Formation (Hawick Group), which are Wenlock in age (Figure 2). South of Rockcliffe Bay, a coastal path can be followed across turbidites of the Ross Formation to Castlehill Point. There, one of the finest exposures of the North Solway Fault is to be seen in the cliffs. The fault plane marks the north boundary of the Upper Palaeozoic Solway Basin and, at this locality, Lower Carboniferous sedimentary rocks (Rascarrel Formation) crop out on the shore. They are downthrown against a mass of porphyritic andesite which had intruded Ross Formation strata prior to fault development. On a clear day, Castlehill Point forms a fine viewpoint along the northern margin of the Solway Basin and across to the Lake District hills and St Bees Head.

## 1 Port Donnel: granodiorite and porphyritic andesite

From the car park walk westwards on the road around Rockcliffe Bay, noting the use of the local grey Criffell granodiorite in some of the stone-built cottages. Large blocks of the rock with fresh surfaces, probably from Dalbeattie, have been used on the foreshore as sea defence. The rock is coarse grained and composed of white plagioclase feldspar accompanied by dark biotite and amphibole. There are numerous dark rounded xenoliths, of a few centimetres diameter; some are hornfelsed country rock (greywacke sandstone) and some are partially assimilated more basic igneous rocks such as quartz diorite. The granodiorite is cut by pale aplite veins, up to 3 cm wide, made of fine-grained quartz, orthoclase and plagioclase feldspar.

The sharp contact between hornfelsed sedimentary rocks and the granodiorite of the Criffell–Dalbeattie Pluton may be seen on the shore at Port Donnel [NX 847 537]. Pods of foliated porphyritic andesite (porphyrite) are present within the sedimentary rocks and crop out on the foreshore in the centre of the bay (Figure 18). The porphyrites form part of a suite of dykes formed during crystallisation stages of the Criffell granodiorite magma (Phillips, 1956).

The granodiorite at Port Donnel is much reddened by haematite staining. It is coarse grained and locally exhibits a foliation picked out by the alignment of plagioclase crystals. Careful inspection of the outcrop reveals small, round dark grey xenoliths of country rock, best seen on wave-washed surfaces. Several small NW-trending faults form shattered and veined zones in the otherwise blocky granodiorite. Small movements on faults of this trend may have occurred intermittently over a long period stretching from early Devonian into Carboniferous times. Prominent joints, produced during the cooling of the pluton, are another feature of the rock.

## **2 Portobeagle Shore: Ross Formation**

Walk back round Rockcliffe Bay and take the signposted coastal track which leads south to Castlehill Point. Between the village and the point there is almost continuous coastal exposure of greywacke turbidites of the Ross Formation. Shore sections at Portobeagle [NX 853 530] are easily accessible.

The greywackes are generally medium to thickly bedded and are calcareous. Typically they are medium-to fine-grained sandstones and are interbedded with grey silty mudstone. Elsewhere, biostratigraphical evidence from graptolites in interbedded shales places the Ross Formation within the early Wenlock (see Excursions 5 and 11).

In contrast to the regional NE strike of Lower Palaeozoic strata, many bedding planes at this locality dip at low angles to the NE. This is because the beds have been folded about fold hinges plunging gently to the NW or SE. There is plenty of evidence for the strata being the right way up; prominent graded bedding and superb examples of ripple crests on upper surfaces of the turbidite units are notable features.

Zones of brecciation and shearing are common, as are numerous east-and NE-trending porphyritic andesite dykes which cut the sedimentary rocks. Some of the dykes are also brecciated.

## **3 Castlehill Point: viewpoint**

From Portobeagle ascend the coastal path past John Nelson's grave, skirting the grazing field to Castlehill Point. Castlehill is the site of an ancient Fort, thought to have been occupied intermittently from about 400 BC until early mediaeval times. Pottery of mediaeval date found here is curated in Dumfries Museum. The viewpoint indicator highlights some of the places visible on a clear day and it is worth spending a few minutes attaching some geology to the scene. To the north, some 5 miles (8 km) away, lies Scree Hill (343 m), composed of hornfelsed, and therefore durable, greywackes. The hill lies within the aureole of the Bengairn quartz diorite intrusion, a part of the Criffell–Dalbeattie complex. To the west, Rough Island, Almorness Point and Heston Isle all comprise Ross Formation strata at the margin of the main Criffell granodiorite. To the NE is the village of Southernness, situated on Lower Carboniferous shallow-marine strata at the northern edge of the Solway Basin.

Southwards some 24 miles (38 km) across the Solway Firth, St Bees Head is formed of Triassic St Bees Sandstone. Thirty miles (48 km) away to the SE Skiddaw (930 m), composed of Ordovician Skiddaw Group siltstones, lies south of the Iapetus Suture in the Lower Palaeozoic mass of the English Lake District.

The spectacular cliff immediately to the NE of Castlehill Point is the fault scarp of the North Solway Fault. This forms the abrupt northern boundary of the Upper Palaeozoic Solway Basin, separating Lower Carboniferous strata on the shore from Lower Palaeozoic turbidites intruded by Silurian-Devonian porphyritic andesites in the cliff.

## **4 Shore section from Castlehill Point to Gutcher's Isle: Rascarrel Formation**

**Locality 4a** Walk down the steep path to the shore and across the shingle to the fault scarp. It represents a faulted unconformity and is formed of a carbonate-cemented fault breccia; the blocks and fragments are mainly of reddened porphyritic andesite, with some greywacke and mudstone. From here, Lower Carboniferous strata are exposed for 1.2 km eastwards along the shore. The section is rocky and can be properly examined only at low tide. The dip is generally to the south and decreases from about 50° within 10m of the fault to less than 15° over a distance of 30 m seawards. The basal strata are conglomerates, rich in clasts of porphyritic andesite and granite. These pass into arkosic sandstones and dark grey laminated siltstones and mudstones (Deegan, 1973; Craig and Nairn, 1956). Some of the sandstones and finer-grained rocks contain marine fossils. All these beds have been assigned to the Rascarrel Formation (BGS, 1993a). Deegan (1973) interpreted the conglomerates and coarse-grained sandstones as the deposits of alluvial fans which passed laterally and upwards into shallow-marine sediments. Rapid lithological variations of this nature may be attributed to intermittent movement on the basin-margin fault and/or external factors affecting sea level. Some of the steeply dipping strata nearest the fault contain liquefaction structures and extensional faults interpreted by Ord et al. (1988) as the effects of seismicity on unlithified or semilithified sandstones.

**Locality 4b** On the shore between Barcloy Hill and Gutcher's Isle, at the east end of the Carboniferous outcrop, there are a number of fossiliferous horizons. In the intertidal zone [NX 860 525] on the east limb of a gently NNE-plunging syncline, dark grey micaceous silty mudstones and siltstones have yielded a marine fauna including the bryozoan *Fenestella*, gastropods and crinoid columnals. The strata are locally full of terrestrial plant remains testifying to the presence of a well-vegetated land surface nearby. There is also evidence of extensive bioturbation, with *Chondrites* burrows particularly plentiful.

At the east end of the sandy bay at Gutcher's Isle [NX 863 526], the faulted margin of the Carboniferous strata extends offshore. Here, Craig and Nairn (1956, p.252) recorded a carbonate-cemented fault breccia with fragments of porphyritic andesite, greywacke and mudstone, overlain by arkosic conglomerate fining upwards into a sequence of interbedded sandstones and black mudstones. The faunas from two of the sandstone horizons comprise the brachiopod *Punctospirifer scabricosta*, bivalves including *Modiola megaloba* and *Myalina* cf. *redesdalensis*, and other molluscs. Macrofossil evidence from these and other small outliers of the Rascarrel Formation is rather equivocal but suggests that the rocks equate with the Powillimount Sandstone Formation (Table 1) of the Southernness-Borron Point area (Excursion 10).

## 5 Portling Bay: Rascarrel Formation

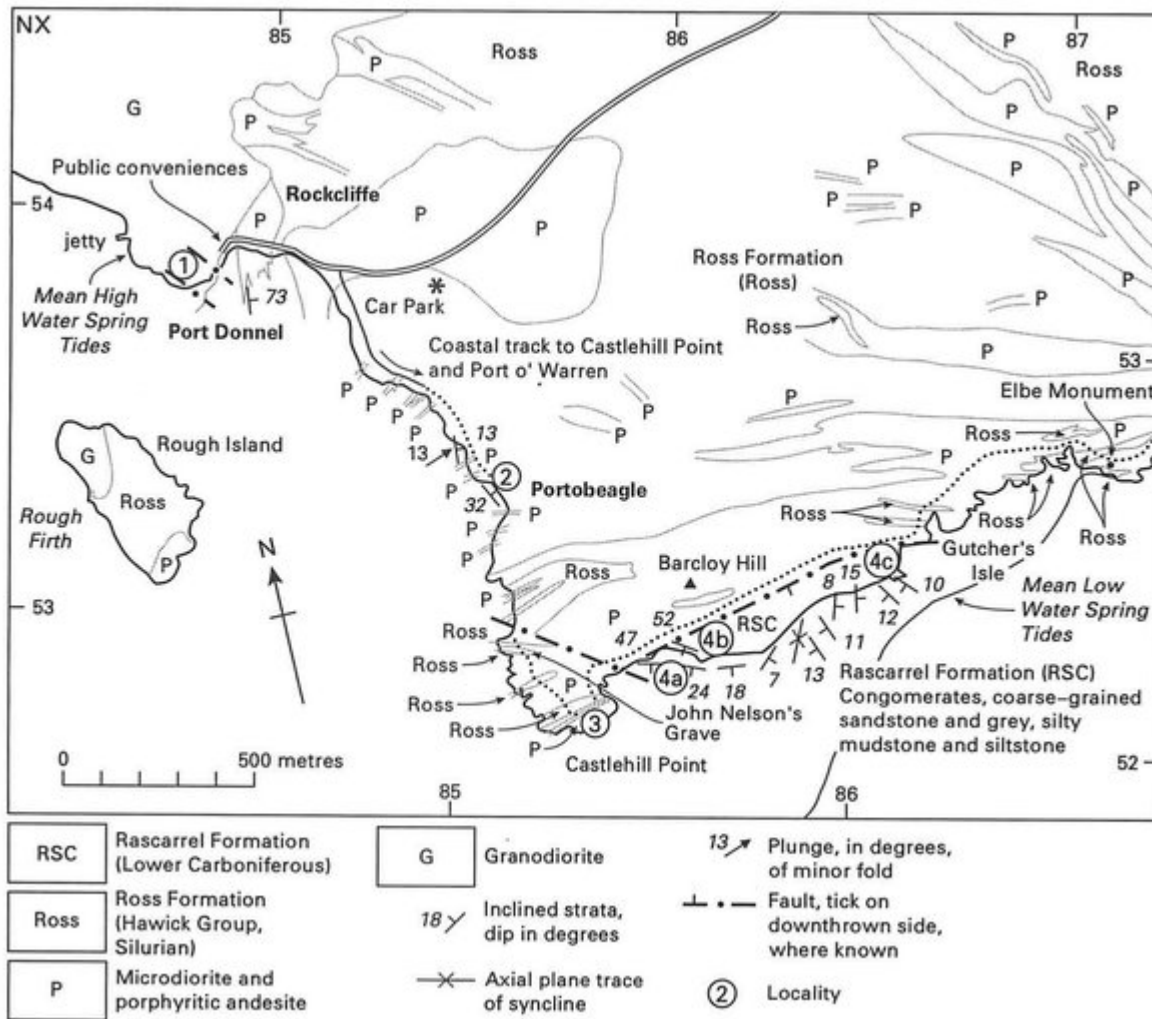
The excursion can be completed at Gutcher's Isle and the route retraced to Rockcliffe, using the coastal path around the south side of Barcloy Hill. However, the excursion may be extended eastwards via the coastal path which eventually leads to Port O' Warren (Figure 19). Care should be taken when traversing this part of the coast; in places the path runs close to vertical cliffs. Those wishing to walk the coastal path should arrange for transport to meet them at the junction of the single track Port O' Warren road and the A710. No parking is available at Port O' Warren or Pording. Walking distance from Gutcher's Isle to the A710 junction is 3 km.

Seaward of the path are good exposures of Ross Formation turbidites which have been intruded by dykes and irregular lenticular bodies of porphyritic andesite; the petrography of these was described by King (1937). Good exposures can be found near the Elbe Monument [NX 8684 5276] (Figure 18). The turbidites are locally brecciated. A thin veneer of green secondary copper minerals coats many of the joint surfaces.

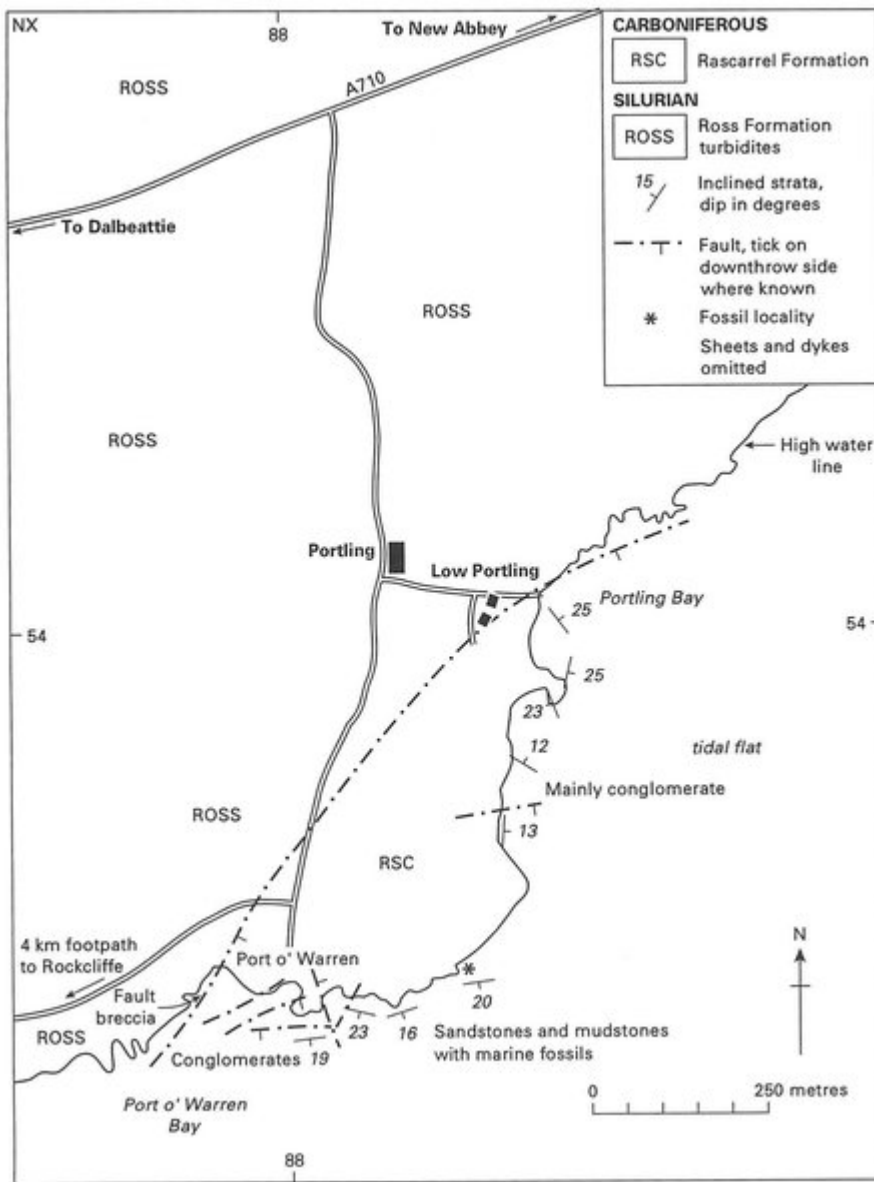
Walk to Port O' Warren and take the narrow road to Portling. If time and tide permit, the shore section at Portling Bay, accessed by the lane leading from Portling to Low Ponling, is worth a visit. Strata of the Rascarrel Formation are exposed between Portling Bay and Port O' Warren Bay. The strata were described by Deegan (1973). As in the Castlehill Point-Gutcher's Isle section, a lower sequence of conglomeratic alluvial fan deposits passes up into fossiliferous dark grey shales and sandstones. Thin limestones, cornstones and cementstones are also present. Craig and Nairn (1956) recorded the following marine fauna, dominated by nautiloids, from a shale near the top of the sequence (position shown by asterisk on (Figure 19)): *Lithophaga* cf. *lingualis* (bivalve), nautiloid gastropod, *Cycloceras* and *Loxoceras*? (nautiloids), *Spirorbis* (worm) and fish remains. Lower in the sequence thin impure limestones within a 9 m-thick arkose

have yielded the calcareous blue-green alga *Bevoastra*, bell erophontid gastropods and ostracods.

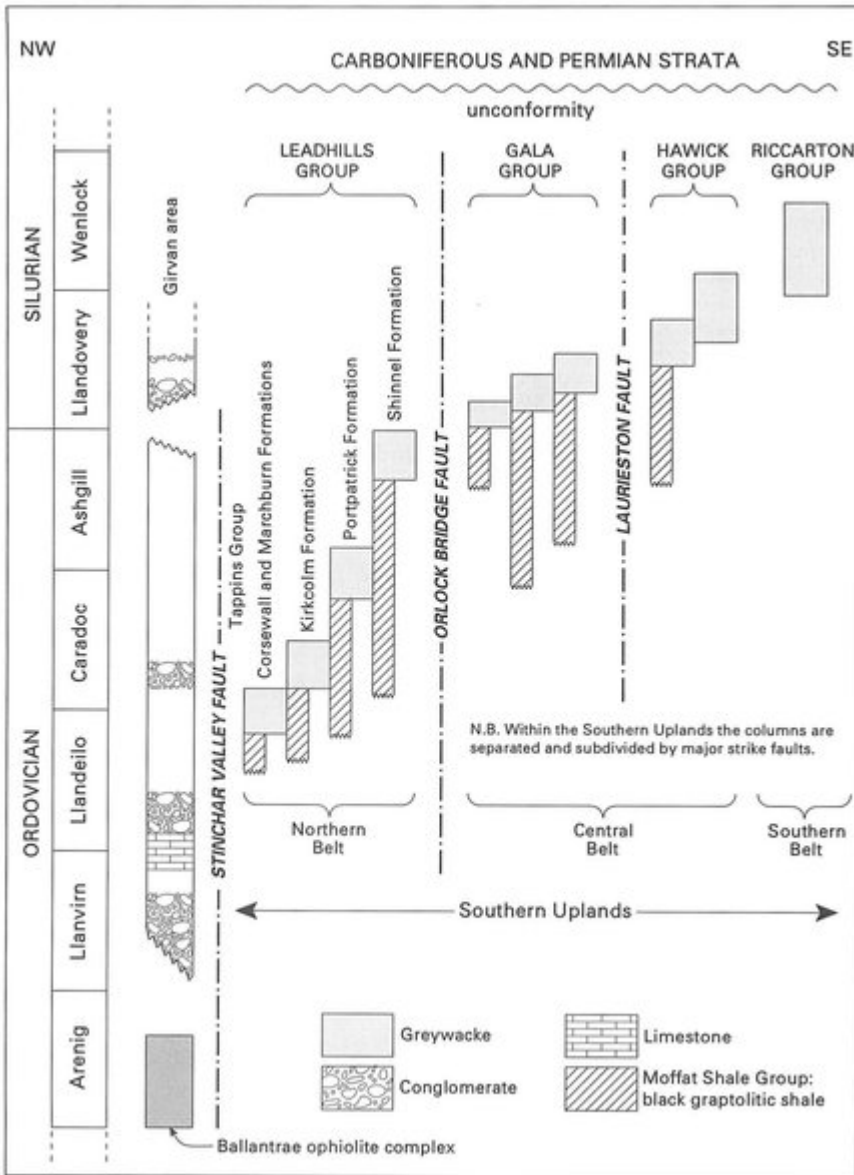
[References](#)



(Figure 18) Locality map and outline geology for Rockcliffe to Gutcher's Isle coastal section.



(Figure 19) Locality map for Portling Bay Outline geology after Deegan (1973).



(Figure 2) Schematic representation of stratigraphical relationships in south-west Scotland.

| AGE                             | LANGHOLM<br>(after Lumsden<br>et al., 1967) | KIRKBEAN GLEN<br>(after Craig,<br>1956; BGS,<br>1993) | SOUTHERNESS-BORRON<br>POINT-HOGUS POINT<br>(after Craig, 1956; BGS,<br>1993) | CASTLEHILL POINT-<br>GUTCHER'S ISLE<br>(after BGS, 1993) |
|---------------------------------|---|---|--|--|
| DINANTIAN (LOWER CARBONIFEROUS) | BRIGANTIAN                                  | Upper Liddesdale Group                                | ?  | Arbigland Limestone Formation                            |
|                                 | ASBIAN                                      | Lower Liddesdale Group                                |  |  |
|                                 |   | Upper Border Group<br>Glencartholm Volcanic Beds      |  |  |
|                                 | HOLKERIAN                                   | Middle Border Group                                   | Thirlstane Sandstone Member  | ? Rascarrel Formation                                    |
|                                 | ARUNDIAN                                    | Harden Beds   | Powillimount Sandstone Formation   |  |
|                                 |   |   | Gillfoot Sandstone Formation   |  |
|                                 | CHADIAN                                     | Lower Border Group                                    | Southernness Limestone Formation   |  |
|                                 |   |   | Syringothyris Limestone  |  |
|                                 | COURCEYAN                                   | Birrenswark Volcanic Formation                        | Kirkbean Cementstone Formation   |  |
|                                 |   |   | ?  |  |
| LATE DEVONIAN                   | Upper Old Red Sandstone                     |   |  |  |
| SILURIAN                        | Riccarton Group                             | Hawick Group  |  | Hawick Group   |

This table does not show relative thickness of different groups, formations and members.

(Table 1) Lower Carboniferous stratigraphy correlated along the northern margin of the Solway Basin.