Corrie Shore, Arran, North Ayrshire

[NS 022 444]–[NS 026 433] and [NS 025 436]

Introduction

The Corrie Shore GCR site, on the Isle of Arran, provides a spectacular and very accessible section of Tournaisian-Arnsbergian strata and is, arguably, one of the most complete sections of Lower Carboniferous age in the west of Scotland. The section crops out for 1 km along the shore from just north of the village [NS 022 444] to about 50 m south of the Corrie Hotel [NS 026 433]. The rocks have a southerly dip and the base of the succession is thus exposed at the northern end of the outcrop and the youngest beds are exposed at the southern end of the section. Close to Corrie Harbour [NS 025 436] the site is extended inland to include outcrops within an old quarry. The section has been described in detail by Tyrrell (1928). It has also been described in several excursion guides (Tomkeieff, 1961; Macgregor, 1965; MacDonald and Hernot, 1983; McKerrow and Atkins, 1989) and in the field exercise manual of Nicholas (2000). The site lies adjacent to the Corrie Foreshore GCR site, described in the *British Upper Carboniferous Stratigraphy* GCR volume by Cleal and Thomas (1996), and the Corrie Shore to Brodick GCR site, described in *the Permian and Triassic Red Beds and the Penarth Group of Great Britain* GCR volume by Benton *et al.* (2002).

Description

A simplified log of the succession is presented in (Figure 2.38). At the base of the section, Lower Carboniferous strata rest on Upper Old Red Sandstone rocks of the Stratheden Group. Several metres of red sandstones, slltstones and mudstones, arranged in fining-upward cycles, can be seen capped by a thick conglomerate (7 m), which is taken as the basal bed of the Kinnesswood Formation (Inverclyde Group, Lower Carboniferous) (McKerrow and Atkins, 1989). The base of the conglomerate is erosive and in places loaded into the underlying mudstone. The conglomerate, which appears to thicken seawards, is generally coarse, though sandy lenses do occur, and includes clasts of quartzite, vein quartz, schist, green sandstone, red siltstone, calcite and andesitic lava (McKerrow and Atkins, 1989). The top of this conglomerate is distinguished by a prominent calcite cement which defines large ovoid patches incorporating grains and clasts of the conglomerate. Above it is an interbedded and coarsening-upward sequence of red slltstones and light-coloured sandstones in which there are three nodular calcrete developments (Tyrrell, 1928; Macgregor, 1965). Within the upper sandstones, McKerrow and Atkins (1989) recorded a bioturbated shale.

The Kinnesswood Formation is sharply overlain by beds of the Clyde Plateau Volcanic Formation (Strathclyde Group) which has at its base a thick (15 m), coarse agglomerate overlain by basaltic lava (140 m). The agglomerate is matrix-supported and contains large casts of basaltic lava which are often highly amygdaloidal. Clasts of red sandstone have also been recorded (McKerrow and Atkins, 1989). The lava development has well-marked columnar jointing but it is only towards its top that an internal flow boundary can be distinguished. At this level and at the top of the development the lava is amygdaloidal, brecciated and reddened.

The overlying beds of the Lawmuir Formation (Strathclyde Group) are not so well exposed. At its base are red shales and sandstones with tuffaceous fragments (20 m). Some of these sandstones are bioturbated (McKerrow and Atkins, 1989) and a thin (0.45 m) red limestone has been recorded (Tyrrell, 1928). Above these, a thin (3 m) altered basaltic lava flow makes a prominent ridge on the shore [NS 025 438]. The beds immediately overlying the lava are not exposed and there is a gap in the sequence of about 10 m before the appearance of a thick (30 m) unit of bedded sandstones. These sandstones may be massive or cross-bedded and in places there is convolution of the bedding. On some major bedding surfaces there is evidence of plant colonization including stigmarian roots. The beds above the sandstone (15 m) are again poorly exposed, but include red siltstones and mudstones with reduction spots. Macgregor (1965) recorded a fragment of ribbed brachiopod shell from this part of the sequence, and a red crinoidal limestone, which appears to be in *situ,* can be found under the boulders on the foreshore.

The Corrie Limestone (Figure 2.39), which occurs next in the sequence, is taken as the local equivalent of the Hurlet Limestone (Tyrrell, 1928), and its base, which is not currently exposed, thus marks the base of the Lower Limestone Formation (Clackmannan Group). On the shore, only the upper parts of the limestone can be seen in a vertical face on the south side of the small harbour. However, more extensive exposures showing up to 4.3 m of limestone are available inland in old quarries and at the entrances to old underground workings of the limestone. The limestone was recorded as being 7 m thick. A characteristic feature of the limestone is the abundance of large gigantoproductid brachiopods, which are often found in a concave-up 'life' position. The limestone in the quarries is overlain by shales (0.5 m) from which a prolific marine fauna has been recorded (Tyrrell, 1928). A thin clay tonstein layer (40 mm) has been recognized from within these shales associated with an earthy layer thought to be a decomposed coal (Huff and Spears, 1989). The shales pass up into siltstones with starved ripples and then into cross-laminated and cross-bedded sandstones. These strata are the first of a series of about six coarsening-upward cycles of shales and siltstone passing up into ripple-laminated or cross-bedded sandstones, which together total about 70–80 m (Tyrrell, 1928; McKerrow and Atkins, 1989). Some of the sandstones contain stigmarian roots and one is a pure white quartz arenite, but no coals have been recorded. Bioturbation is present in some beds (McKerrow and Atkins, 1989) and soft-sediment deformation is common in some of the siltstones and sandstones. The topmost and thickest sandstone (which was formerly quarried and which forms the Ferry Rock at [NS 026 435]) contains fine examples of vertical cylindrical water-escape structures and associated deformation structures resembling sand volcanoes.

The Conic Limestone and these clastic cycles are assumed to encompass the whole of both the Lower Limestone Formation and the Limestone Coal Formation, although the two formations cannot be distinguished. The base of the Upper Limestone Formation is recognized at the base of a thin limestone that lies about 7 m above the top of the sandstone at Ferry Rock. This red-coloured crinoidal limestone (0.6 m) contains a range of gastropods, bivalves and cephalopods, but is best characterized by the presence of *Latiproductus latissimus* and thus resembles, and is correlated with, the Index Limestone of the mainland (Tyrrell, 1928). The 'Index Limestone' is separated from the underlying sandstone by reddish shales and sandstones, and within the overlying similar reddish shales and silty sandstones (10 m) a further two thin red limestones occur. The lower (0.3 m) of these contains small gastropods and productoid brachiopods, and the upper is distinguished by an abundance of palaeotaxodont bivalves. A white sandstone (2 m) separates these beds from a similar but less well-exposed sequence (about 7 m) within which two (McKerrow and Atkins, 1989) or three (Tyrrell, 1928) thin red limestones have been recognized. These are erosively overlain by a sandstone with a conglomeratic base, which is the first horizon within the Upper Carboniferous succession (MacDonald and Herriot, 1983; Cleal in Cleal and Thomas, 1996).

Interpretation

The total thickness of Lower Carboniferous rocks at Corrie (about 370 m) is considerably less than at Laggan, 9 km to the north, where there are about 730 m of strata. To the south and south-west, Carboniferous successions in Arran become even thinner and less complete (Tyrrell, 1928), indicating that Conic lay towards the margin of the East Arran Basin situated within the present area of the Firth of Clyde.

As elsewhere in Scotland, the base of the Carboniferous sequence at Corrie cannot be defined on macropalaeontological criteria and in the past several different criteria have been used to place a lithological boundary (Tyrrell, 1928; MacDonald and Herriot, 1983; McKerrow and Atkins, 1989). Currently the presence of pedogenic fabrics in the cement at the top of the thick conglomerate and in the overlying calcretes is used to place these and associated beds within the Kinnesswood Formation of the Inverclyde Group (Paterson and Hall, 1986). The conglomerate itself is a coarse channel deposit cutting down into the top of the Stratheden Group, and the overlying beds represent floodplain sands, silts and muds with palaeosol developments. A marine influence might be indicated by the bioturbation at one horizon (McKerrow and Atkins, 1989), though the evidence is not unequivocal. The Kinnesswood Formation is sharply overlain by the volcanic units of the Clyde Plateau Volcanic Formation and there may be a marked time gap between the Inverclyde Group and Strathclyde Group at this point. At Laggan there is about 100 m of succession that is not found at Corrie (I'yrrell, 1928; McKerrow and Atkins, 1989).

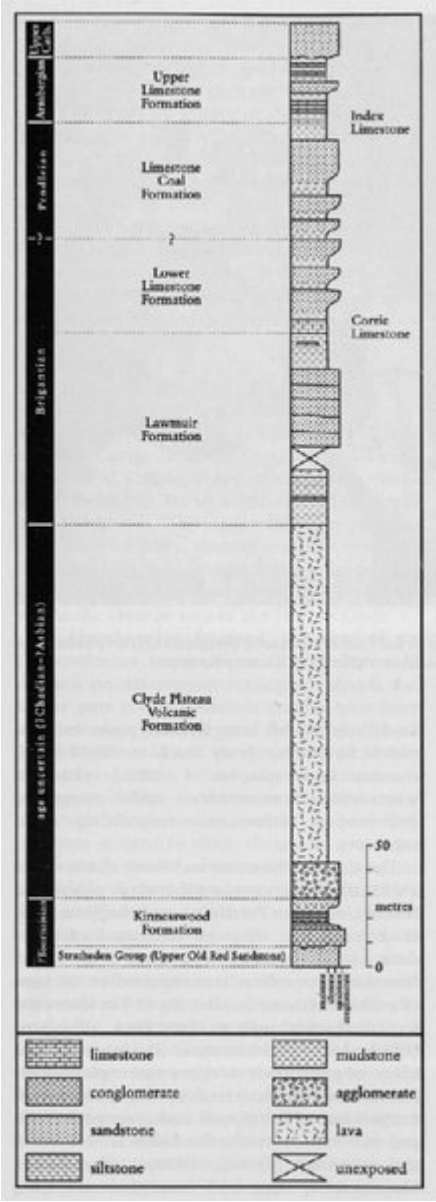
The basal agglomerate of the Clyde Plateau Volcanic Formation has been interpreted as a lahaar deposit and the dearth of flow boundaries in the overlying lava might indicate either that there was very little time for weathering between eruptions or that the unit is largely the result of a single eruption that was ponded to make an unusually thick unit. Although the top of the lava development is weathered and the basal beds of the Lawmuir Formation do contain volcanic fragments, there is no development at Corrie of the Kirkwood Formation in which beds are almost entirely formed from eroded and weathered volcanic material. The Lawmuir Formation consists largely of floodplain mudrocks, siltstones and sandstones with, towards the middle of the sequence, a group of higher-energy fluvial sandstones. Low down in the sequence a marine influence might be indicated by bioturbation in a mudrock (McKerrow and Atkins, 1989) and by the thin limestone. Marine horizons may also be present in the upper part of the formation. However, the first well-developed and undoubtedly marine horizon is the Corrie Limestone. The correlation of this limestone with the Hurlet Limestone (Tyrrell, 1928) may need to be reconsidered in the light of debate regarding the correlation of the Dockra Limestone of Ayrshire (Wilson, 1979; Whyte, 1981) but, whatever its exact horizon, the Corrie sequence is remarkable in that it lacks any other representatives of marine horizons of the Lower Limestone Formation. Also remarkable is the lack of coals from the levels that approximate to the Limestone Coal Formation. It is possible that coals were once present but have been volatilized by the metamorphic effects of the Northern Granite. Some of the extensive, and possibly secondary, reddening of strata within the sequence may also be linked to porewater circulation stimulated by the granite intrusion and carrying iron leached from the New Red Sandstones or Old Red Sandstones.

The uppermost groups of thin reddened limestones equate broadly with the Upper Limestone Formation of the mainland, though only the basal limestone can be correlated with any degree of certainty. They do, however, show that marine conditions did occasionally penetrate to the western end of the Midland Valley in late Pendleton and Arnsbergian times.

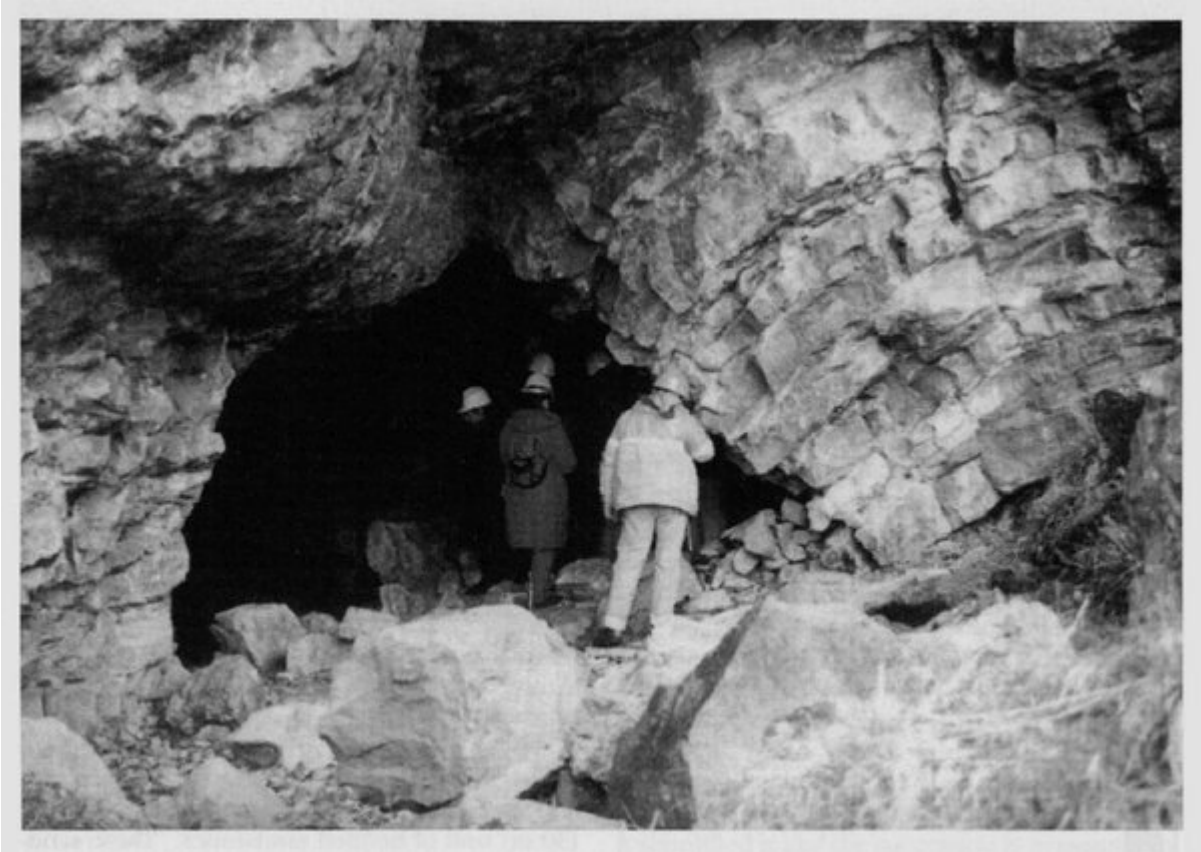
Conclusions

The Corrie Shore GCR site offers an outstanding and nearly complete outcrop from the Kinnes-swood Formation (Tournaisian) through to the Upper Limestone Formation (Arnsbergian). Together with the adjacent Upper Carboniferous GCR site (Conde Foreshore) described by Cleal and Thomas (1996) it offers arguably the most continuous Carboniferous section in north-west Britain. It also provides invaluable information on Lower Carboniferous palaeogeography and palaeoenvironments at the western end of the Midland Valley.

References



(Figure 2.38) Simplified sedimentary log of the Lower Carboniferous succession at the Conic Shore GCR site.



(Figure 2.39) Folded beds and entrance to old workings in the Corrie Limestone (Brigantian, Lower Limestone Formation, Clackmannan Group) at the Conic Shore GCR site. (Photo: R. Kanaris-Sotiriou.)