Barns Ness Coast, East Lothian

[NT 697 782]–[NT 745 753]

Introduction

The coastal exposures between Lawrie's Den and Skateraw, 2–7 km south of Dunbar [NT 697 782]–[NT 745 753], are the best natural exposures of the Lower Limestone Formation and of the topmost beds of the Strathclyde Group (Aberlady Formation) in the south-east of the Midland Valley. The succession consists of cyclical sequences of fossiliferous marine limestones and mudrocks passing up into deltaic mudstone–sandstone units, which are often capped by thin coals. The different marine bands have distinctive features and the section is a vital link in correlating between sites in Scotland and England. Davies *et al.* (1986) summarized the geology and previous work on the area. Guides to the shore exposures between Barns Ness and Catcraig have been provided by Craig (in Mitchell *et al.* 1960; in Craig and Duff, 1975) and Clarkson (in McAdam and Clarkson, 1986).

Description

The geological succession at this site (Figure 2.8) is displayed, almost in full, on the foreshore between Catcraig and Barns Ness [NT 714 773]–[NT 723 773]. Foreshore outcrops along strike between Barns Ness and Chapel Point [NT 723 773]–[NT 740 758] display the upper parts of this succession and provide a link to the outcrops of the upper half of the sequence at Skateraw. North of Catcraig and White Sands, complex outcrops in the vicinity of Millstone Neuk and Lawrie's Den provide lateral equivalents to the upper parts of the sequence.

The lowest beds of the succession are the Longcraig Middle Limestone (2 m) and an underlying marine bioturbated sandstone (*c.* 2 m), which, with an overlying fireclay, coal and marine mudstone, belong to the Longcraig Member of the Aberlady Formation (Strathclyde Group). The Longcraig Middle Limestone is a nodular argillaceous limestone, which contains towards its top a well-developed coral biostrome dominated by compound corals (Macaroni Rock). The corals are well displayed on the foreshore in front of the limekilns at Catcraig, in exposures, which also strikingly show the basin-like hollows that mark the upper surface of the limestone. These potholes, which are ladled with clay, are a karstic solution feature linked to palaeosol formation, and stigmarian roots and rootlets extend down from the coal into the limestone. The rootlets are often surrounded by sideritic rhizocretions and within the limestone there has been a development of pedogenic carbonate concretions. This Carboniferous soil development has been accompanied by a bleaching of part or all of the limestone to a creamy white colour and the lower limit of the bleached zone transgresses the bedding. The fluctuation in sea level that resulted in this superimposition of palaeosol features on a marine limestone was followed by renewed transgression and the development of a thin mudstone, rich in crinoidal debris, *Eomarginifera* and *Streblopteria,* which underlies the Longcraig Upper Limestone. This sequence, extending from the prominent potholed surface on the top of the Longcraig Middle Limestone to the base of the Longcraig Upper Limestone, is illustrated in (Figure 2.9). The principal feature of the 6 m-thick Longcraig Upper Limestone is a coral band, composed almost entirely of *Koninckophyllum echinatum,* which lies about 1 m below its top. This band, known locally as 'Dunbar Marble' has in the past been exploited to a limited extent as a poor-quality ornamental stone. The limestone passes conformably up into a 5 m-thick mudrock and sandstone sequence in which the thinly bedded sandstones show ripple marks and trace fossils. Capped by a thin coal smut, these clanks are overlain by the 1 m-thick Skateraw Lower Limestone. The single post of this limestone has an abundance of gigantoproductids at the base and a few compound corals and bellerophontids towards the top. The clastic part of this cycle (3.8 m) consists of silty mudstone and silty sandstone rich in ironstone concretions passing up into soft grey fireday with abundant *Stigmaria* on which lies a thin coal. The megaspores of this coal, and of the coal below the Longcraig Upper Limestone, were studied by Spinner (1969).

The overlying Skateraw Middle Limestone (5 m) is made up of a series of limestone beds separated by thin shale partings. The basal shale is thin and contains fusain fragments and marine fossils. Within the lower parts of the limestone

there are gigantoproductid brachiopods and abundant *Zoophycos* traces. Chaetetid sponges are also common and occur in two forms: small, bun-shaped colonies and flat disc colonies. The latter invariably rest on and protect lensoid accumulations of fossil debris in which bioclasts are often coated by algae. In a band close to the top of the limestone the problematic fossil *Saccaminopsis fusulinaformis* occurs in abundance and above this there is a thin argillaceous band whose upper surface has scattered strews of echinoid plates, each patch representing the disturbed remnants of a single test. Clark (1960) has recorded a diverse conodont fauna from the Skateraw Middle Limestone and associated shales.

Immediately above the limestone at both Barns Ness and Skateraw there is a marine mudstone (1 m) and a thin sideritic limestone, the Skateraw Upper Limestone (0.4 m). In inland quarry exposures the equivalent beds are thicker and more variable and contain an extremely diverse marine fauna. Palaeoecological studies (Whyte, 1973) have indicated that they formed in a mud-bank complex and that the exposures within the site represent an off-bank facies. Although the bank facies is not represented here, similar facies occur at Invertiel Quarry (see GCR site report, this chapter). Skateraw is the type locality for the small blastoid *Astrocrinites bennei,* and for the juvenile pro-ductoids known as *Etheridgina complectens,* which occur attached to crinoid stems (Etheridge, 1876). Specimens from the shales at Catcraig were used by Carruthers (1910) in his classic study of evolution in *Zaphrentis delanouei.*

The sequence of shales, siltstones and sandstones that overlie the Skateraw Upper Limestone is 30 m thick. It contains a sparse marine fauna at the base and marine fossils have also been found in a band within the sandstones towards the top of the succession. Close to Chapel Point the sandstones are cross-bedded or flat bedded with parting lineation and in places show highly convoluted laminations. The uppermost sandstone is intensely bioturbated and contains stigmarian roots. At Barns Ness the equivalent beds appear to be siltier in nature.

The Chapel Point Limestone (2.8 m) sits directly on this sandstone and is a brown-weathering dolomitic limestone, which can be traced along strike from Barns Ness to Chapel Point. Features of the basal sandy crinoidal limestones have been described by Cain (1968), and crinoidal debris and *Zoophycos* traces are common throughout the limestone. Other fossil material is scarce but small colonies of *Siphonodendron* and large bellerophontids also occur. In the middle beds large chert nodules contain sponge spicules and other fine fossil debris. At Barns Ness the upper surface of the limestone is rich in valves of *Spirifer trigonalis* and spines of *Archaeocidaris urii.* Farther north, near Millstone Neuk, the top of the bed has in the past yielded complete specimens of *Archaeocidaris.*

About 12 m of strata occur above the Chapel Point Limestone and these are dominated by fine to coarse sandstones. Towards the top they include the Barns Ness Limestone, a sandy crinoidal limestone (1 m) which contains *Zoophycos* and which dies out on the foreshore north of Barns Ness. The equivalent of this unit is present north of White Sands, as a similar sandy limestone, but in a repeated exposure farther to the north it appears to be represented by a shale containing *Lingula* (Davies *et al.,* 1986).

Interpretation

The Barns Ness Coast GCR site together with the GCR site at Cove provide an almost complete section through the Lower Carboniferous sequence of the Cockbumspath Outlier. The Barns Ness section displays extremely well the cyclical characters of the Aberlady Formation and Lower Limestone Formation that result from the interaction between marine conditions and fluvio-deltaic sedimentation. The several cycles are of varying thickness and the component marine and non-marine portions show a wide range of facies representing the palaeoenvironmental complexities of this situation. Within the marine intervals, faunal concentrations such as the *Saccaminopsis,* gigantoproductid and coral bands have long attracted attention, but the overall character and bedding of the limestones is also of importance in stratigraphical correlation and in palaeoenvironment interpretations. The marine mudrocks associated with the limestones also show significant faunal assemblages and those at the base of the Longcraig Upper Limestone and at the top of the Skateraw Middle Limestone are especially important. The varied clastic units within the fluvio-deltaic parts of the sequence show interesting sedimentary and trace-fossil assemblages and the range of palaeosols and thin coals is particularly significant. The well-developed palaeosol above the Longcraig Middle Limestone is particularly noteworthy.

The marine faunas within the sequence are typical of the Brigantian Stage and fragments of upper Brigantian (P_2) goniatites have been recorded from the mudrocks above the Skateraw Middle Limestone at localities about 1 km from the

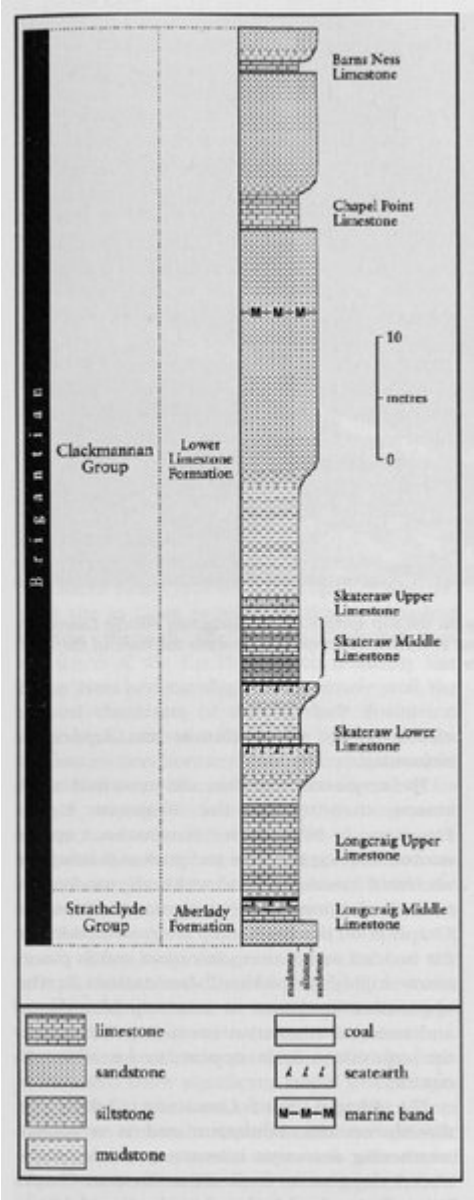
site (Currie, 1954). Palynological studies confirm this age, and in the Catcraig to Barns Ness section the NM–VF miospore zone boundary was placed within the mudrocks above the Skateraw Middle Limestone (Neves *et al*., 1973).

The thickness of the Barns Ness section is considerably less than that of equivalent sections elsewhere in eastern Scotland and northern England, but nevertheless it provides a vital link between the two areas. The Longcraig Upper Limestone appears to be the equivalent of the Hurlet Limestone at the base of the Lower Limestone Formation (Figure 2.4) and the disconformity represented by the palaeosol above the Longcraig Middle Limestone can be recognized in other sections, below the Hurlet Limestone, across the Midland Valley of Scotland. The Skateraw Middle Limestone is the equivalent of the Blackhall Limestone and the mudstones above the limestone contain distinctive elements of the Neilson Shell Bed Fauna (Whyte, 1973) which forms a useful guide assemblage for this interval (Wilson, 1966). Fragments of *Sudeticeras newtonense,* a P_2 goniatite, also occur in these mudrocks (Currie, 1954). The Skateraw Lower Limestone can be correlated with the Shields Bed horizon of the Midland Valley and though not stratigraphically diagnostic the correlative limestones at Aberlady and in East Fife are similar in thickness and in containing gigantoproductids. The correlation of the poorly fossiliferous Chapel Point Limestone and Barns Ness Limestone is less certain as this part of the sequence also differs in character from other areas and shows interesting internal lateral facies variations: However, the Barns Ness Limestone has been compared to the 'Hosie' Limestone of St Monance, which is a sandy crinoidal limestone rich in *Zoophycos.* When compared with sections in Northumberland there is a striking similarity between the Longcraig Upper Limestone and the Skateraw Middle Limestone and the Eelwell Limestone and Acre Limestone respectively (see Spittal Shore GCR site report, Chapter 3). The fauna of the mudrocks above the Acre Limestone includes species found at Barns Ness and Skateraw, including components of the Neilson Shell Bed Fauna.

Conclusions

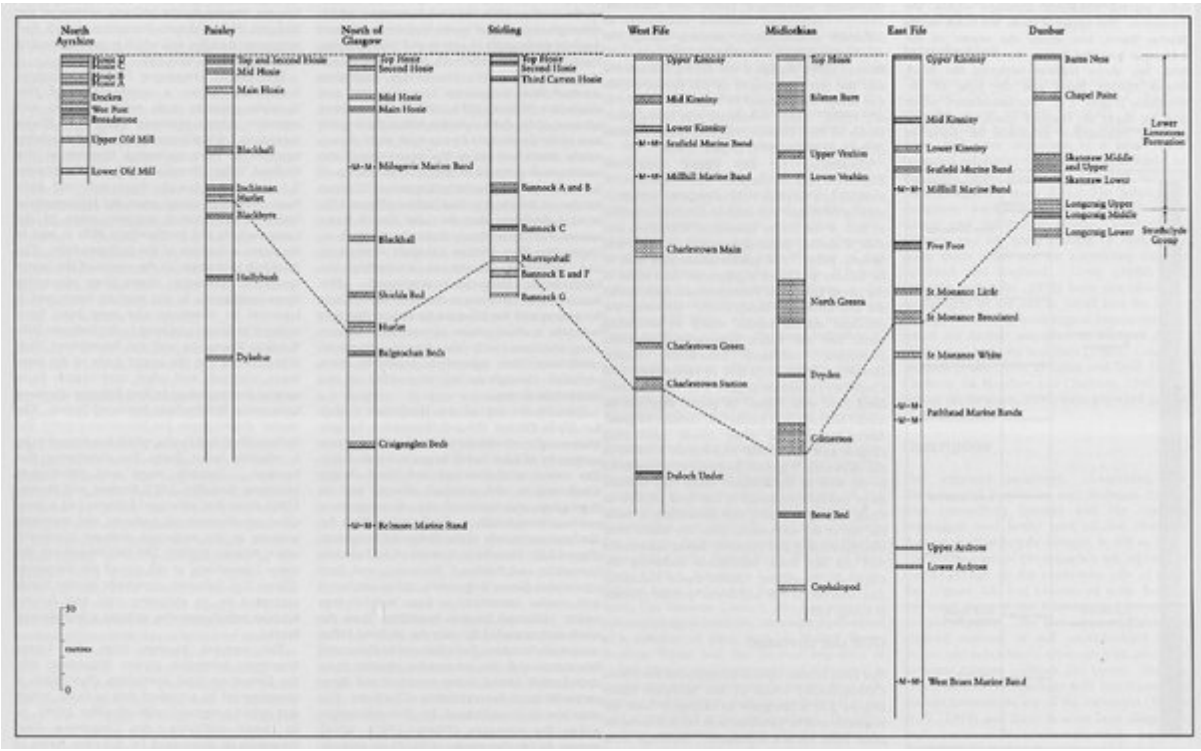
The Barns Ness Coast GCR site is a key site providing a link between Dinantian sections in England and Scotland. It shows a nearly complete section of the Lower Limestone Formation (Brigantian) and the underlying topmost part of the Strathclyde Group. The section is only half the thickness of equivalent successions in the Lothians and Fife, and shows marine limestones, intervening clastics and well-displayed thin coals. This site is noteworthy for the occurrence of palaeokarstic surfaces (proving emergence and subaerial solution), coral biostromes, gigantoproductid brachiopod and *Saccaminopsis* bands, and megaspore-rich coals. The marine faunas are stratigraphically useful and have been the subject of detailed palaeoecological studies.

References



(Figure 2.8) Simplified sedimentary log of the lower part of the Lower Limestone Formation (Brigantian) at the Barns Ness Coast GCR site. Based on various sources and including information from Davies et al. (1986).

(Figure 2.9) Palaeokarst solution hollow infilled by clay on the top surface of the Longcraig Middle Limestone at the Barns Ness Coast GCR site. Above this a thin coal and shale is developed beneath the base of the overlying Longcraig Upper Limestone. Note the 10 cm scale bar. (Photo: M.A. Whyte.)



(Figure 2.4) Correlation of the principal marine horizons in the Brigantian Lower Limestone Formation and uppermost part of the Strathclyde Group in the Midland Valley from North Ayrshire to Dunbar. Note that most of the named units figured here are, unless otherwise stated, limestones (names abbreviated). Based on various sources and including information from George et al. (1976), Cameron and Stephenson (1985), Wilson (1989) and Francis (1991).