Bracken Bay–Longhill Point, South Ayrshire

[NS 277 182]–[NS 283 187] and [NS 292 188]–[NS 317 194]

Introduction

The long coastal section from Bracken Bay [NS 277 182] to Longhill Point [NS 317 194] reveals a stratigraphically significant section of the Ballagan Formation (Tournaisian Inverdyde Group) and a unique relationship between this and Upper Carboniferous rocks. The outcrop is situated towards the eastern margin of the East Arran Basin but is disrupted by the intrusive complex of the Heads of Ayr Vent (described in detail as part of an igneous site of Carboniferous age described in a companion GCR volume by Stephenson *et al.,* 2003), and by a number of NW–SE-trending dolerite dykes. Descriptions of the site have been published by Eyles *et al.* (1949), and in guides by Bassett (1958) and Whyte (in Bluck, 1973; in Lawson and Weedon, 1992).

Description

At the western end of Bracken Bay the Lower Carboniferous rocks of the Ballagan Formation are faulted against older rocks of the Stratheden Group (Upper Devonian), which are massive, occasionally pebbly, pink and white sandstones and which have yielded the fish scales of *Bothriolepis major,* and a specimen of *Asterolepis.*

The Ballagan Formation consists of alternations of cementstones and mudrocks. The cementstones are thin (less than 0.3 m), hard, argillaceous dolomitic limestones. They are grey in colour but weather to a buff or creamy-brown colour. Some bands may be nodular. The mudrocks, which are a grey to greenish-grey colour, are calcareous and not usually very fissile. Variations in Ca/Mg ratios and insoluble residue content recorded in these beds by Freshney (reported in Belt *et* al., 1967) were interpreted as the product of carbonate re-distribution from mudrocks into the cementstones by penecontemporaneous downward movement of pore fluids. A few thin beds of fine-grained, micaceous sandstone and thicker and coarser, current-bedded sandstones also occur in the sequence. The thinner sandstones may show ripple marks and desiccation cracks. The latter are also found in the mudrocks. Some of the mudrocks, notably in outcrops 400 m to the east of the Heads of Ayr Vent, show salt pseudomorphs. In this vicinity a mudrock layer contains a fauna of *Lingula, Euestheria striata, Spirorbis,* small bivalves and fish remains (Bassett, 1958; Whyte in Bluck, 1973; Whyte in Lawson and Weedon, 1992). Bands rich in ostracodes are also found a little lower in the sequence. Within the Heads of Ayr Vent an included mass of cementstone contains abundant bivalves. Indeterminate plant remains have been recorded from the sequence, and in Bracken Bay [NS 283 186] a cementstone horizon about 100 m above the base of the formation has yielded a significant Tournaisian miospore assemblage (Sullivan, 1968; Neves *et al.,* 1973; and see (Figure 2.40)).

Towards the top of the Ballagan Formation, a unit (15–20 m) of well-bedded tuff or agglomerate forms the eminence on which Greenan Castle is built. The tuff contains many large fragments derived from the Lower Old Red Sandstone (lavas and sedimentary rocks) and from the Ballagan Formation. In addition pieces of fossil wood impregnated with calcite, carbonated peridotite and a large feldspar crystal have also been recorded (Eyles *et al.,* 1949). The tuff rests with apparent conformity on a sandstone and is overlain by tuffaceous shales and cementstones. The characters of the tuff resemble tuffs within the Heads of Ayr Vent and appear to have been erupted from that volcano.

On the shore near Longhill Point the Ballagan Formation is disconformably overlain by strata belonging to the Upper Carboniferous (Namurian) Passage Formation which consist of greenish, plant-bearing sandstones overlain by basalt lavas.

Interpretation

The alternating cementstones and mudrocks of the Ballagan Formation are interpreted as having formed from wide, shallow water bodies in a lagoonal or protected coastal-plain environment (Belt *et al.,* 1967). The dolomitic character of the cementstones and the association with desiccation cracks and salt pseudomorphs indicates that the climate was arid, that salinities were at times elevated and hypersaline, and that the water bodies occasionally dried out. The rhythmic character of the sequence may reflect alternating wetter and drier periods. Such environments of high physiological stress are inimical to life and the Ballagan Formation usually contains little or no organic remains. The faunas recorded from the Bracken Bay to Longhill Point section are thus particularly important and the unique presence of the inarticulate brachiopod, *Mugula,* indicates a marginal marine connection.

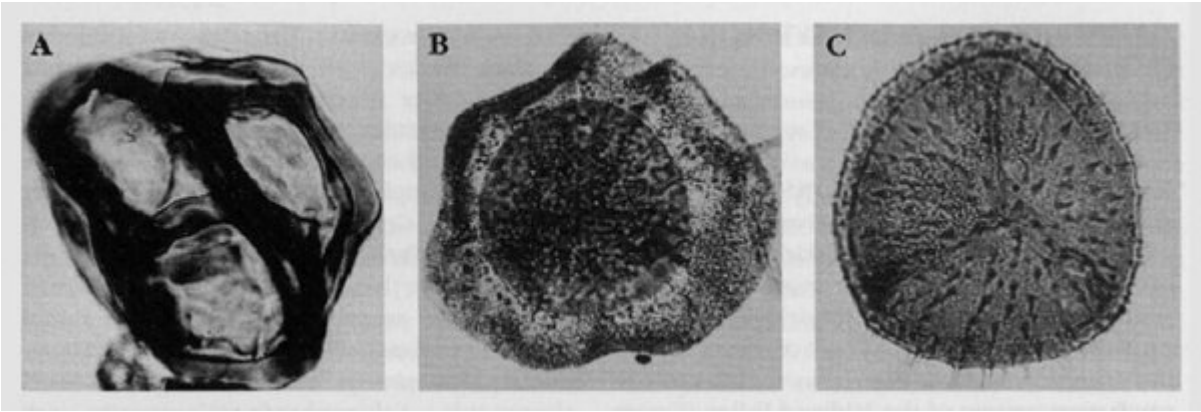
The miospore flora recorded from a cement-stone band is of great stratigraphical importance since it contains spores diagnostic of a Tournaisian (CM Zone) age (Sullivan, 1968; Neves *et al.,* 1973; and see (Figure 2.2) and (Figure 2.40); the first clear record of Tournaisian rocks within the Scottish Carboniferous succession. The fish fauna of the sandstones at the western end of Bracken Bay show that these are of Late Devonian (Fammenian) age (Weston in House *et ed.,* 1977; Paterson and Hall, 1986). These floral and faunal records are of crucial value in delimiting the position of the basal Carboniferous boundary within the Midland Valley.

The Ballagan Formation is overlain disconormably by sedimentary rocks and lavas of the Passage Formation (Upper Carboniferous). Thus here the whole of the Clyde Sandstone Formation (Inverclyde Group), the Strathclyde Group sedimentary formations, and the Lower Limestone, Limestone Coal and Upper Limestone formations are absent. The agglomerates of Greenan Castle, which are interbedded within the Ballagan Formation, indicate a volcanic event that pre-dates the eruption of the Clyde Plateau Volcanic Formation (Strathclyde Group).

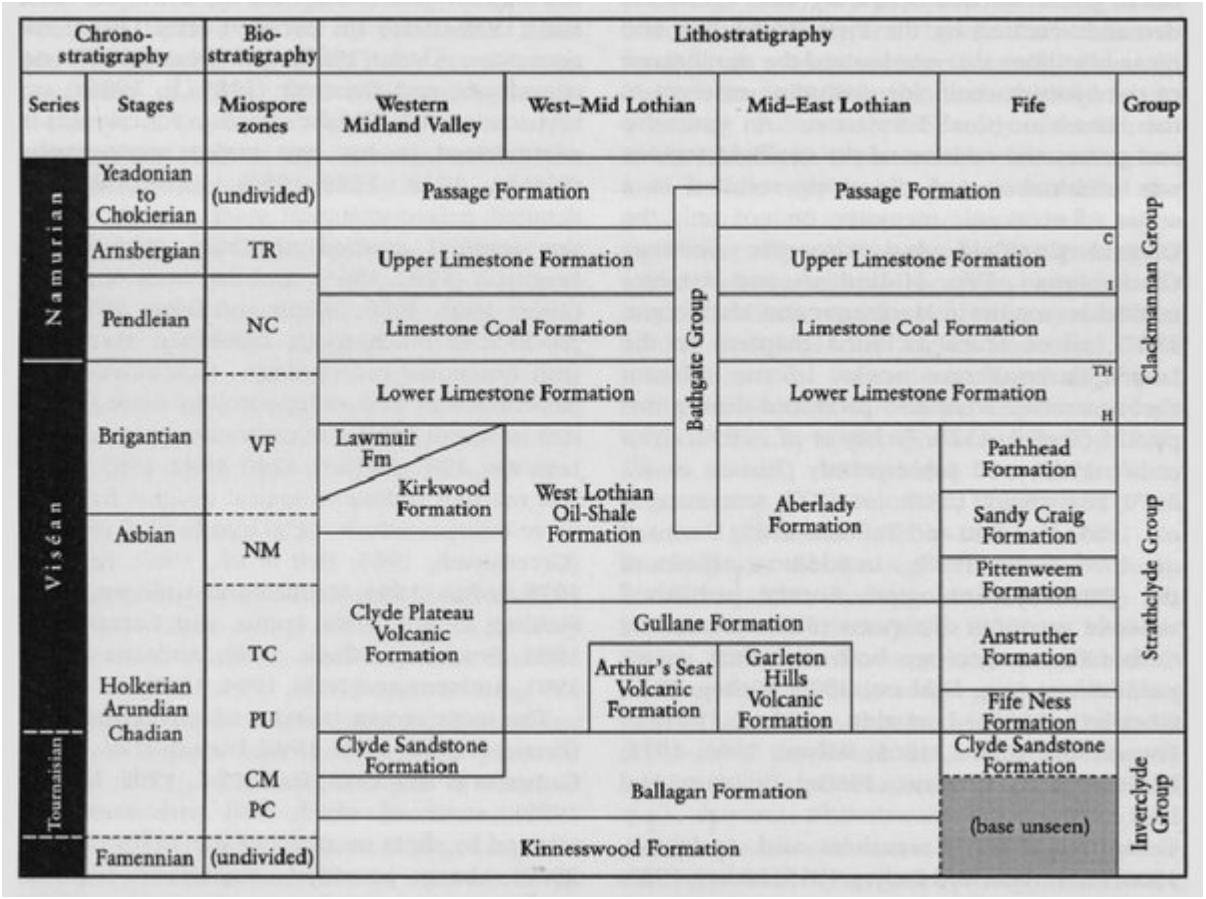
Conclusions

The sequence at Bracken Bay to Longhill Point offers exceptional sections of the Ballagan Formation (Inverclyde Group) which are critical to the understanding of the early Carboniferous stratigraphy, sedimentology and palaeogeography of the Midland Valley. Key features include the presence of an unusual fauna that has been influential in establishing the depositional environment and setting of the formation, and the occurrence of Tournaisian miospores, which, in association with fish fossils recorded from the underlying Stratheden Group (Fammenian) beds, have helped to delimit the position of the Devonian–Carboniferous boundary in the west of Scotland. The age of interbedded volcanics and the great stratigraphical break between the Tournaisian and Upper Carboniferous (Namurian) rocks are further distinctive features of this locality.

References



(Figure 2.40) Tournaisian miospores from the Ballagan Formation (Inverclyde Group) at Bracken Bay. A — Knoxisporites pristinus (x 710); B — Auroraspora macra (x 820); C — Grandispora echinata (x 810). Reproduced from Sullivan (1968) by kind permission of the Palaeontological Association.



(Figure 2.2) Simplified Lower Carboniferous stratigraphical chart for the Midland Valley of Scotland. Note that below the Brigantian Stage, the position of stage boundaries is uncertain and that below the NM miospore zone only recorded zones are indicated. (H — Hurlet Limestone; TH — Top Hosie Limestone; I — Index Limestone; C — Castlecary Limestone.) The Bathgate Group comprises the Salsburgh Volcanic Formation, the Bathgate Hills Volcanic Formation and the Kinghorn Volcanic Formation. Based on various sources and including information from Whyte (1981), Chisholm et al. (1989) and Browne et al. (1996, 1999).