Garpel Water, East Ayrshire

[NS 690 255]

Introduction

The Garpel Water GCR site [NS 690 255] is a south bank tributary of the River Ayr which it joins close to the town of Muirkirk, 13 km WNW of Cumnock. Its course runs across the southern limb of the Muirkirk Syncline providing important outcrops of strata within the Muirkirk Basin, a small basin close to the south-west margin of the Midland Valley (Figure 2.1). The discontinuous exposures show key horizons of the Lower Limestone Formation (Brigantian) and the Upper Limestone Formation (Arnsbergian), which also have features of wider significance within the Midland Valley as a whole. The geology of the Muirkirk Basin and of the Garpel Water outcrops has been described by Eyles *et al.* (1930) and Davies (1972).

Description

In the Garpel Water, the exposures of the Lower Limestone Formation provide sections of three marine horizons. The oldest beds exposed are partial exposures of the Hawthorn Limestone, which is the lowest limestone in the Lower Limestone Formation. These are beds of shelly limestone and calcareous shales (1.7 m). About 8 m of strata separate these beds from the higher part of the Hawthorn Limestone, which contains solitary corals and large gigantoproductid brachiopods set in a nodular white-weathering limestone with reddish-weathering sideritic patches on its upper surface. The limestone has been invaded by rootlets from the overlying bed of mudstone, which, in addition to rootlets, contains sphaerosiderite and has a polygonal pattern of sandstone-filled shrinkage cracks. Above the mudstone there is an alternating series of hard and soft sandstones with rootlets overlain by dark carbonaceous shales with carbonate nodules.

The Garpel Water also proves an excellent section of the next marine band in the local sequence, the Muirkirk Wee Limestone, which is 0.7 m thick and rich in gigantoproductids. It rests on dark shales and is overlain by dark, unfossiliferous shales with large ironstone nodules (0.7 m) capped by an ironstone band with rootlets (0.15 m) and a grey seatearth (0.8 m) with rootlets. The seatearth is overlain by dark shales with plant fragments, which become siltier at the top with siderite and carbonate nodules. Overlying these are 7.3 m of limestone and calcareous shales, which provide a nearly complete section of the McDonald Limestones. Corals, trilobites, gastropods and the bivalve *Pernopecten sowerbii* have been recorded from these beds (Davies, 1972) as well as a diverse range of brachiopods including *Avonia youngiana, Echinoconchus, Latiproductus latissimus* and other productoids, chonetoids, *Schizophoria, Composita* and orthotetoids. Snook (1999) has made a detailed study of the faunas and facies of these beds and of the Muirkirk Wee Limestone.

Exposures of the Upper Limestone Formation include outcrops of four marine horizons, towards the middle of the formation, together with associated strata. In ascending order, these are the Birchlaw Limestone, Tibbie Pagan's Limestone, the Orchard Beds and the Blue Tour Limestone. An incomplete section of the Birchlaw Limestone shows a sandy limestone (1.8 m) with brachiopods (*Pleuropugnoides* and *Schellwienella rotundata*) and bivalves. The Tibbie Pagan's Limestone lies about 60 m higher in the formation at the eponymous locality of Tibbie Pagan's Bridge, the only exposure of this unit on the southern limb of the Muirkirk Syncline. Here, 1.5 m of shelly limestone is overlain by fossiliferous calcareous mudstones and limestone bands (1.8 m). Fenestellids, bivalves including *Aviculopecten, Nuculopsis gibbosa* and *Phestia attenuata,* gastropods and brachiopods such as *Eomarginifera, Latiproductus, Pleuropugnoides* and orthotetoids have been recorded from this locality (Davies, 1972). Above this, the Orchard Beds (*c.* 11 m) are a series of calcareous shales and siltstones with thin limestone bands. The Garpel Water outcrop is the best exposure of this horizon in the Muirkirk Basin, and a diverse fauna of small solitary corals, bryozoans, brachiopods, bivalves, gastropods, scaphopods, cephalopods, trilobites and crinoid remains occurs within it (Davies, 1972). The Blue Tour Limestone lies about 25 m higher in the section, and up to 6 m of limestone and limestone with calcareous shale partings can be seen (Davies, 1972). As noted by Davies (1972), a thicker section was recorded in the past (Eyles *et al.,* 1930) when the limestone was also seen to rest on a coal seam (Davies, 1972). Muir and Hardie (1956) have provided a brief petrographical description and chemical analysis of this limestone. Its fauna includes *Clisiophyllum, Composita,* '*Dielasma*', *Pugilis, Eomarginifera, Latiproductus* and other productoids, trilobites and crinoid columnals (Davies, 1972), and Graham (1988) has recorded the problematical bivalve *Placunopsis? propediscus* from the horizon. In addition, Currie (1954) recorded the goniatites *Anthracoceras paucilobum* and *Cluthoceras,* and Wright (1936, 1939, 1950–1960) described *Allagecrinus garpelensis* from the Blue Tour Limestone at this locality. Two other crinoid species, *Platycrinites muirkirkensis* and *Woodocrinus whytei,* have also been described from the Garpel Water (Wright, 1950–1960). Although the exact horizons are not given, the former is from the Upper Limestone Formation and the latter from the Lower Limestone Formation. Wright (1950–1960) also recorded *Ureocrinus bockshii, Platycrinites ?crassiconicus* and *Platycrinites ?spiniger* though their source horizons are also uncertain.

Interpretation

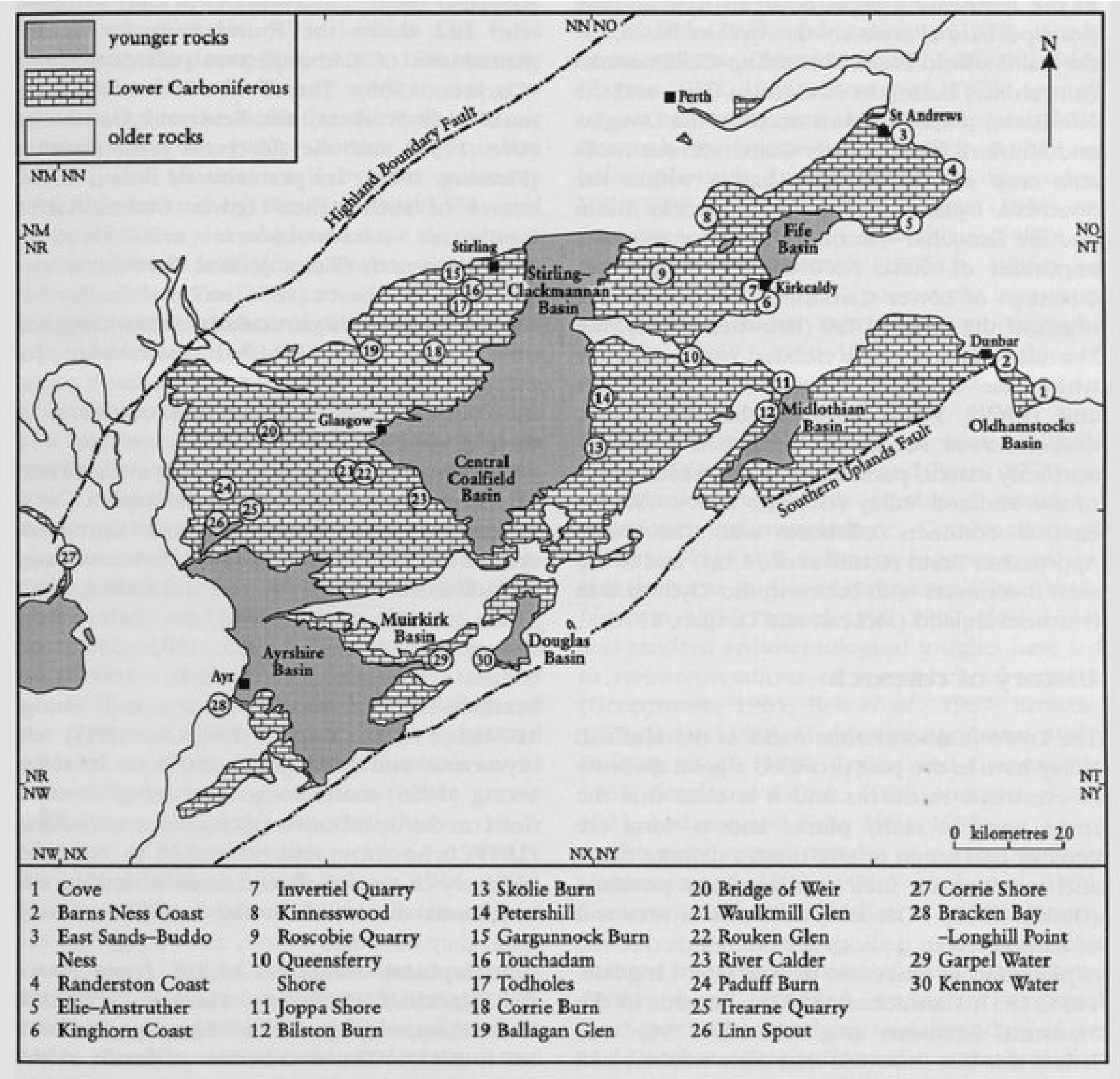
The Hawthorn Limestone is the local name for the Hurlet Limestone (Davies, 1972; Whyte, 1981; and see (Figure 2.2)) and the fauna recorded is typical of this horizon in the Muirkirk Syncline. The bleached and nodular top to the Hawthorn Limestone, which is also typical in this area (Davies, 1972), indicates the presence of a disconformity accompanied by penecontemporaneous weathering of the limestone. The regional significance of this break has been discussed by Whyte (1981). The rapid transition from limestone to fireclay above the Muirkirk Wee Limestone suggests that uplift also occurred locally at this horizon. The McDonald Limestones may include up to four limestone horizons, which are thought to equate to the four limestones of the Hosie Limestones of the Central Coalfield Basin (Davies, 1972; Whyte, 1981). In the Garpel Water, Snook (1999) tentatively identified limestone bands equivalent to the two lower units of the Hosie Limestones, the Main Hosie Limestone and Mid Hosie Limestone. He also indicated that the position of the Second Hosie Limestone might lie within a carbonate-rich series of shales and limestone bands (Snook, 1999). The equivalent of the Top Hosie Limestone, whose top marks the top of the Lower Limestone Formation, is not exposed in the Garpel Water.

The Birchlaw Limestone, in the Upper Limestone Formation, is correlated with the Shell Band Limestone of the Douglas Coalfield (Lumsden 1967a; Davies, 1972), but the equivalent horizon in the Central Coalfield Basin is less certain (Lumsden, 1967a; Wilson, 1967). In the past, the Birchlaw Limestone appears to have been mis-correlated with the Index Limestone, which is the basal limestone of the Upper Limestone Formation (Eyles *et al.,* 1930). A characteristic feature of the Index Limestone is the presence of *Latiproductus* c.f. *latissimus,* but, as is well shown in the Garpel Water, it is not confined to this horizon (Davies, 1972). The Tibbie Pagan's Limestone, Orchard Beds and Blue Tour Limestone are correlated respectively with the Lyoncross Limestone, the Orchard Limestone and the Calmy Limestone of the Central Coalfield (Eyles *et al.,* 1930; 'Wilson, 1967; Davies, 1972; and see (Figure 2.5)). An interesting feature of the Orchard Beds (Orchard Limestone) is that *Edmondia punctatella* is found at their base. In other areas this species is more usually found in a band at the base of the Calmy Limestone (Eyles *et al.,* 1930; Wilson, 1967; Davies, 1972) but in the Muirkirk Basin It has only been found at the earlier Orchard Beds horizon (Eyles *et al.,* 1930; Davies, 1972). The goniatites found in the Blue Tour Limestone are indicative of the E_2 Zone (Currie, 1954). The crinoid fauna recorded by Wright (1950–1960) is particularly significant as this is the only locality in the Upper Limestone Formation of the Midland Valley from which complete dorsal cups have been recorded. The Garpel Water is the type locality for three of the six species listed from it, namely *Woodocrinus whytei, Allagecrinus garpelensis* and *Platycrinites muirkirkensis* (Wright, 1950–1960). A paratype of the brachiopod *Leptagonia smithi* comes from the Orchard Beds (Brand, 1972) and the holotype of *Placunopsis? propediscus* comes from the Blue Tour Limestone (Graham, 1988).

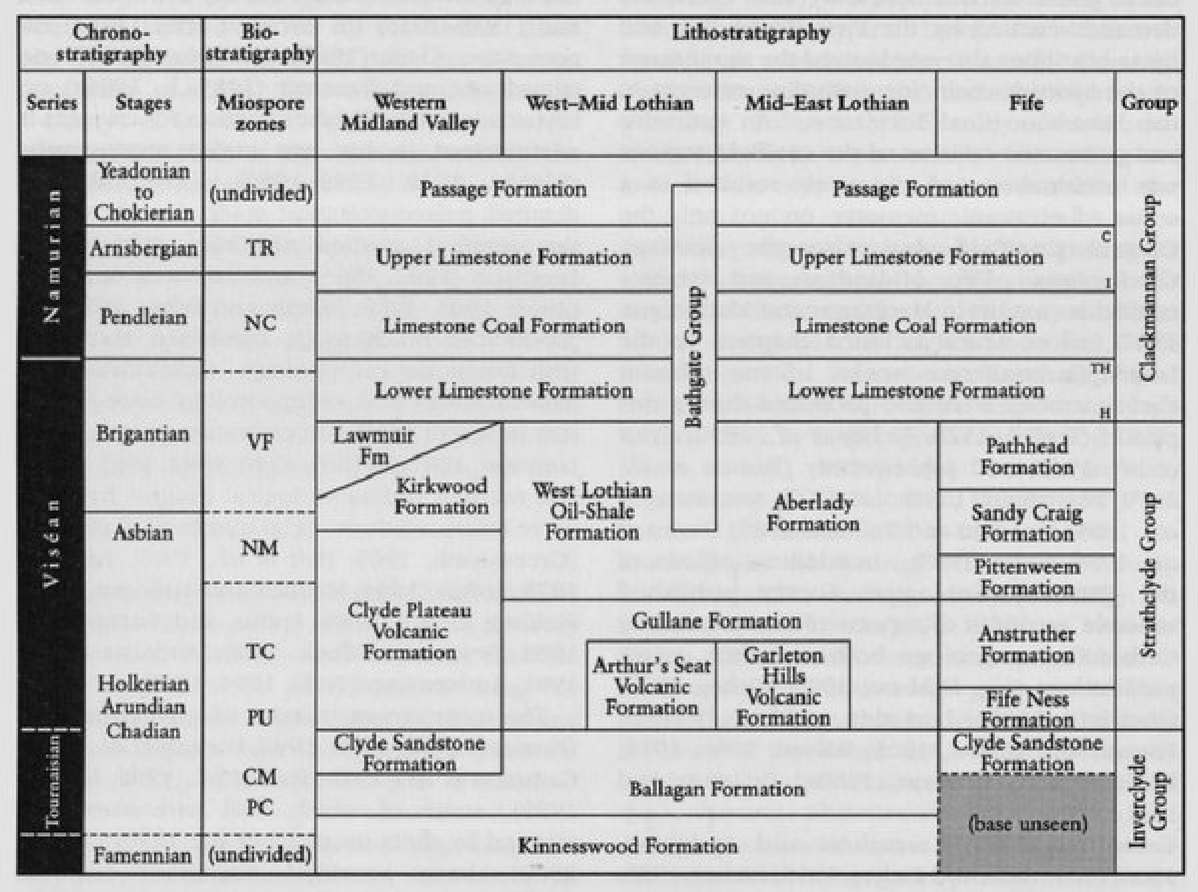
Conclusions

The natural exposures in the Garpel Water GCR site provide highly important representative sections of the Lower Limestone Formation (Brigantian) and the Upper Limestone Formation (Arnsbergian) within the Muirkirk Basin. The limestones contain rich faunas, which are of taxonomic and biostratigraphical importance and of considerable use in correlation with other parts of the Midland Valley and in palaeogeographical reconstructions. The sequence also shows evidence of a significant disconformity within the Lower Limestone Formation, and contains rich crinoid faunas, which are unique within the Upper Limestone Formation.

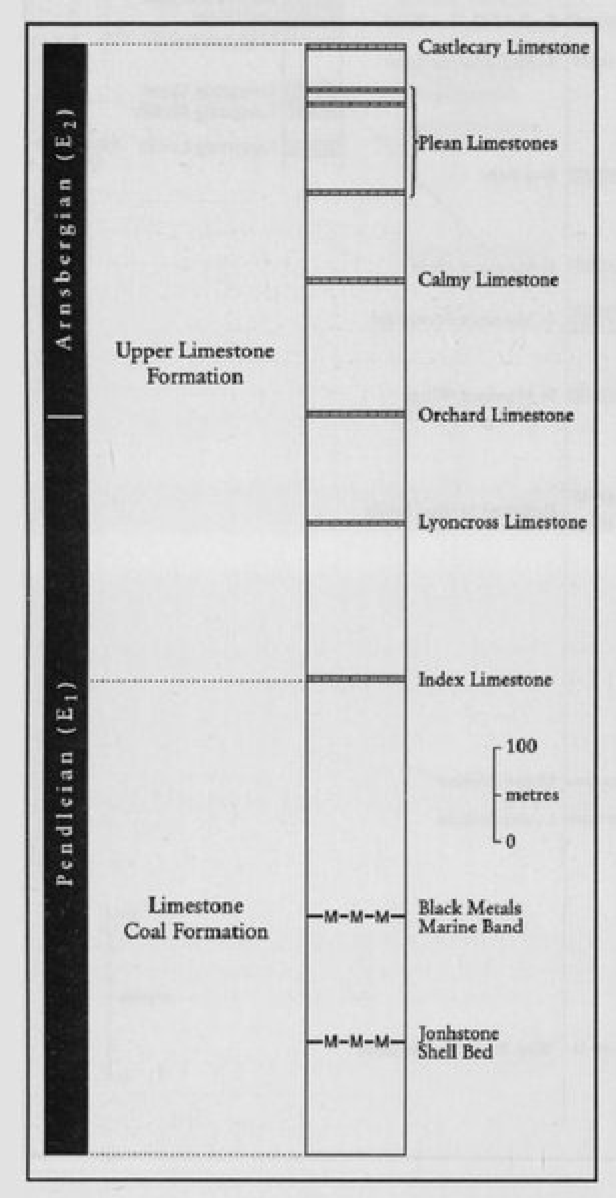
References



(Figure 2.1) Geological map of the Midland Valley Basin showing the distribution of Lower Carboniferous outcrops, sedimentary basins and the location of GCR sites described in the text. Based on information from [British] Geological Survey maps of the area (principally Institute of Geological Sciences, 1979a).



(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).



(Figure 2.5) Simplified stratigraphy of the Limestone Coal Formation and Upper Limestone Formation of the Midland Valley (as typified by the Kincardine Basin succession) showing the position of the principal marine horizons. Based on Ramsbottom et al. (1978) and Cameron and Stephenson (1985). maximum subsidence (Read and Merriam,