Kennox Water, South Lanarkshire

[NS 777 247]–[NS 792 259]

Introduction

Kennox Water is a tributary of the Douglas Water about 7 km SSW of Douglas and at the southern end of the Douglas Coalfield. In a series of natural exposures along its course [NS 777 247]–[NS 792 259] it provides the most complete Lower Carboniferous section within the Douglas Coalfield and a section of invaluable regional importance to the understanding of Lower Carboniferous stratigraphy and palaeogeography of the south-western part of the Midland Valley area. The oldest members of the succession belong to the Inverclyde Group (Tournaisian), and the youngest beds are close to the top of the Upper Limestone Formation of the Clackmannan Group (Arnsbergian). At its base, and within the succession, there are a number of stratigraphically significant unconformities. Full details of the sequence have been given by Lumsden (1964, 1967a,b) who also provides lucid reviews of previous work on the area. Lumsden (1971) has also written a brief excursion guide to the section.

Description

The outcrops on the Kennox Water show a sequence of strata belonging to the Inverclyde Group (Tournaisian) unconformably overlain by beds of the Lawmuir Formation (Strathclyde Group) and the Lower Limestone, Limestone Coal and Upper Limestone formations (Clackmannan Group, Brigantian to Arnsbergian). The general succession is illustrated in (Figure 2.41). The beds assigned to the Inverclyde Group rest with a marked angular discordance on Lower Devonian rocks of the Lower Old Red Sandstone. At the base of the Inverclyde Group, which has a thickness of 75 m, there is a conglomerate and the rest of the sequence is made up of massive, medium-grained sandstones with bands of conglomerate and thin red or green mudrocks. Prior to Lumsden's work (1967a), a conglomeratic horizon about 13 m below the top of the Inverdyde Group was taken as marking the base of the Carboniferous sequence and the beds below were assigned to the Old Red Sandstone.

The Inverclyde Group is capped by a pale-coloured seatearth, which is overlain by calcareous mudstones (1 m) and a limestone. The limestone, the Douglas Main Limestone, is correlated with the Hurlet Limestone (Lumsden, 1967a; Whyte, 1981) and thus its base defines the base of the Lower Limestone Formation (Figure 2.2). Its basal shales and the seatearth thus represent a very thin development of the Lawmuir Formation (Brigantian). The Douglas Main Limestone is 10 m thick and consists of beds of limestone with shale partings and thicker bands of calcareous mudstone. It contains corals, echinoderm debris and brachiopods including gigantoproductids. An assemblage of *Antiquatonia* spp., *Avonia youngiana* and *Krotovia spinulosa,* which is found in the limestone both at Kennox Water and elsewhere, is, within the Douglas Basin, unique to this horizon (Lumsden, 1967a). The limestone is overlain by sandstone (7.5 m) with thin, rooty siltstones and mudstones in the middle and a seatearth and thin coal at the top. There is also a seatearth at the base and rootlets penetrate down into the top of the limestone, which is bleached. Reworked clasts from the limestone occur in the basal parts of the fireclay and there is also in-situ brecciation in the top of the limestone.

The middle parts (about 8.5 m) of the Lower Limestone Formation, including the Douglas Wee Limestone position and the lower part of the McDonald Limestones succession, are not exposed in the Kennox Water, but there are exposures of the upper two limestones of the McDonald Limestones. The lower limestone is 1.0 m thick and separated from the upper limestone (0.4 m), which has a red-weathering top, by 1.0 m of calcareous shales. The fauna of these beds includes corals, crinoids, bryozoans, trilobites, bivalves (including *Wilkingia* and *Pernopecten sowerbii*) and a wide variety of brachiopods (Lumsden, 1967a). The McDonald Limestones are correlated with the Hosie Limestones of the Central Coalfield (Lumsden, 1967a; Whyte, 1981) and the top of the highest limestone marks the top of the Lower Limestone Formation.

The Kennox Water provides excellent representative sections of the Limestone Coal Formation (Pendleian), which is about 60 m thick in this area (Lumsden, 1964). The beds are arranged in cycles with variable developments of the

following sequence: coal, overlain successively by mudstone, slltstone and sandstone capped by the seatearth of the next coal. In the Kennox Water there is an excellent exposure of one of the principal marine bands of the formation, the Johnstone Shell Bed (Figure 2.41). This is a 2 m-thick, highly fossiliferous, calcareous mudstone containing *Edmondia, Limipecten, Lingula squamiformis* and brachiopods including productoids, spiriferoids and rhynchonellids (Lumsden, 1964). The Shell Bed rests on a thin coal, the McDonald Coal (0.45 m), and is separated from the top of the McDonald Limestones by about 10 m of rooty sandstones and slltstones with clayband ironstones. Above the Johnstone Shell Bed, clayband ironstones and mudstones (2 m) containing *Lingula* pass up into rooty sandstones, siltstones with ironstone nodules and seatearths with rootlets (14 m), which also contain, in the upper parts, two coal seams. These are the Six Foot Coal and the Thirty Inch Coal, both of which are developed as two leaves separated by seatearths. Above this, a mudstone marks the position of the Black Metals Marine Band, though fossils have not been found in the outcrops in the Kennox Water. There is a gap of about 10 m above this mudstone. In the uppermost 20 m of the Limestone Coal Formation a number of coal seams can be recognized separated by mudstones, sandstones and seatearths. The lowest of these coals is the Nine Foot Coal (2.7 m), which is in bands with dirt partings, and above this is the Seven Foot Coal (1.9 m), which is in two leaves of coal with thin dirt partings separated by a mudstone and seatearth. The highest coal, the Ell Coal, is 0.5 m thick and lies 5–6 m below the top of the formation.

The outcrops of the Upper Limestone Formation (Pendleian-Arnsbergian) are not complete but supply sections typical of the formation as well as exposures of some of its key horizons. At the base the Index Limestone is well displayed and consists of 2.4 m of limestone with shale bands resting directly on a thin coal. The fauna includes *Latiproductus* cf. *latissimus.* The limestone is directly overlain by at least 12 m of medium- to coarse-grained, cross-bedded sandstone. The sequence between the sandstone and the Calmy Limestone is poorly exposed. A small outcrop of the Calmy Limestone does occur in the Kennox Water and its marine fauna includes *Latiproductus* cf. *latissimus, Spirifer* and *Rugosochonetes.* The Calmy Limestone is 1.5 m thick, including a calcareous mudstone parting. At the base is a band with the anomalodesmatid bivalve *Edmondia punctatella.* Corals, bryozoans, crinoids, *Composita, Echinoconchus,* and other productoids, orthotetoids, *Dentalium, Edmondia, Sanguinolites* and trilobite fragments are among the faunal elements found in the limestone and shales. The limestone is overlain by siltstones (5 m), which pass up into alternating sandstones and siltstones (10 m). Above these, broken exposures show at least 20 m of thin coals, mudstones, siltstones, thinly bedded sandstones and rooty seatearths. Ironstone bands and nodules are common, and a band containing the non-marine bivalve *Curvirimula* and three marine bands known as the 'Plean Limestones' have also been recognized. The fauna of these includes crinoids, *Lingula* spp., productoids and other brachiopods, bivalves including *Schizodus* and *Edmondia,* orthoconic cephalopods and gastropods. The thickest coal is about 1 m thick.

At Kennox Water these are the highest beds of the Upper Limestone Formation exposed and they are faulted against the Lower Coal Measures. However, it is, thought that the highest beds of the Upper Limestone Formation, including the Castlecary Limestone, are missing locally and that the formation is unconformably overlain by the Lower Coal Measures (Lumsden, 1967b).

Interpretation

The basal beds of the Inverdyde Group have been deposited from a fluvial regime in a semiarid climate and have filled in hollows in an irregular landscape following a period of uplift and erosion (Lumsden, 1967a, 1971). They have been compared to the caicrete-bearing beds of the Kinnesswood Formation (Inverclyde Group) elsewhere, but calcretes are lacking in the Kennox Water outcrops. In view of the uncertainty as to their age, and because of the proximity of sediment sources in the Southern Uplands, the beds in the Kennox Water could be the lateral equivalent of other parts of the Inverclyde Group. Thus assignment of the sequence to a definite formation could be premature.

The Inverdyde Group is overlain by a very thin development of the uppermost parts of the Strathclyde Group. The two groups are separated from each other by a major unconformity in which most of the Strathclyde Group and possibly the upper parts of the Inverclyde Group are missing. This unconformity must also have had a considerable relief as earlier beds (over 70 m) of the Lawmuir Formation, including three marine bands, occur in other parts of the Douglas Basin. The fireclay at the boundary between the Inverdyde Group and Strathclyde Group reflects a climatic change to more humid seasonally wet conditions.

Although not completely exposed, the Lower Limestone Formation is thinner in the Kennox Water than in the northern part of the Douglas Coalfield (Lumsden, 1967a) and thinner than the formation as developed in the Central Coalfield (Goodlet, 1957). It shows a smaller proportion of argillaceous strata and an increased relative proportion of limestone and sandstone. The increased sandstone content may reflect proximity to sediment sources in the Southern Uplands, but lithological ratios may be affected by the presence of disconformities such as the one above the Douglas Main Limestone (Whyte, 1981). The clastics represent deltaic Infill of the basin, which suffered intermittent uplift while the marine beds were deposited in a shallow-shelf environment. The faunas of the McDonald Limestones were included by Snook (1999) in his multivariate study of facies and faunas in the Hosie Limestones. The contention that the gigantoproductids of the Douglas Main Limestone could be differentiated from those of a lower horizon has not been supported by Wilson (in Lumsden, 1967a), who also found no pattern of variation in the colonial coral *Siphonodendron.*

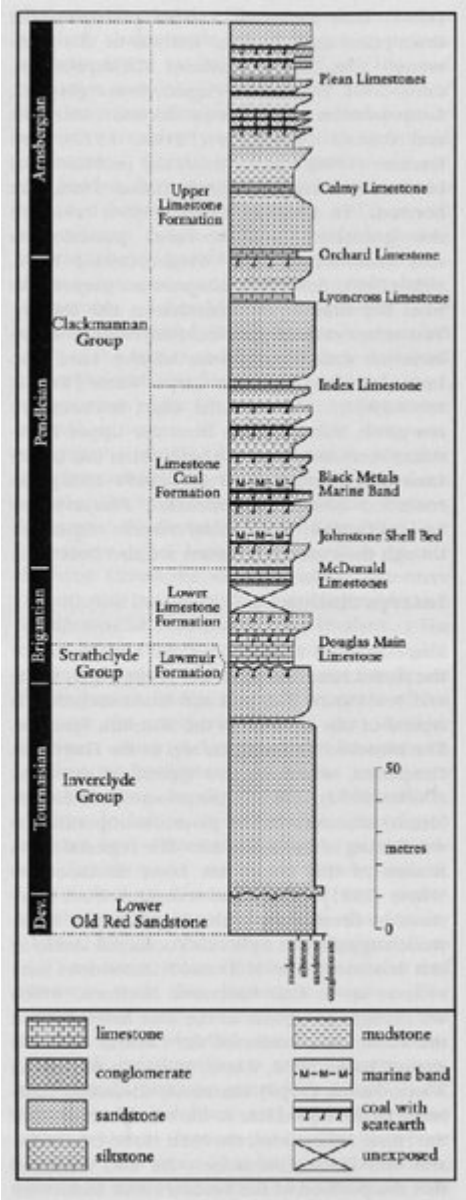
The Limestone Coal Formation shows a marked change in facies and a dominance of delta-top environments. The formation of coalsindicates a humid climate with high water tables. Marine conditions are less commonly developed and although the position of the two principal marine bands of the Limestone Coal Formation can be recognized, only one contains marine fossils. The presence of these bands is an aid in correlating coal seams both in the Douglas Coalfield and in other areas of the Midland Valley (Lumsden, 1964).

A reversion to a more Yoredale type of cyclicity is shown in the Upper Limestone Formation, with open marine shelf sequences alternating with deltaic and delta-top beds. In the Kennox area, sandstones can again be thick and prominent, as above the Index Limestone. The variable sequences above the Calmy Limestone suggest unstable oscillating conditions on a delta top with occasional marine influxes (Lumsden, 1971).

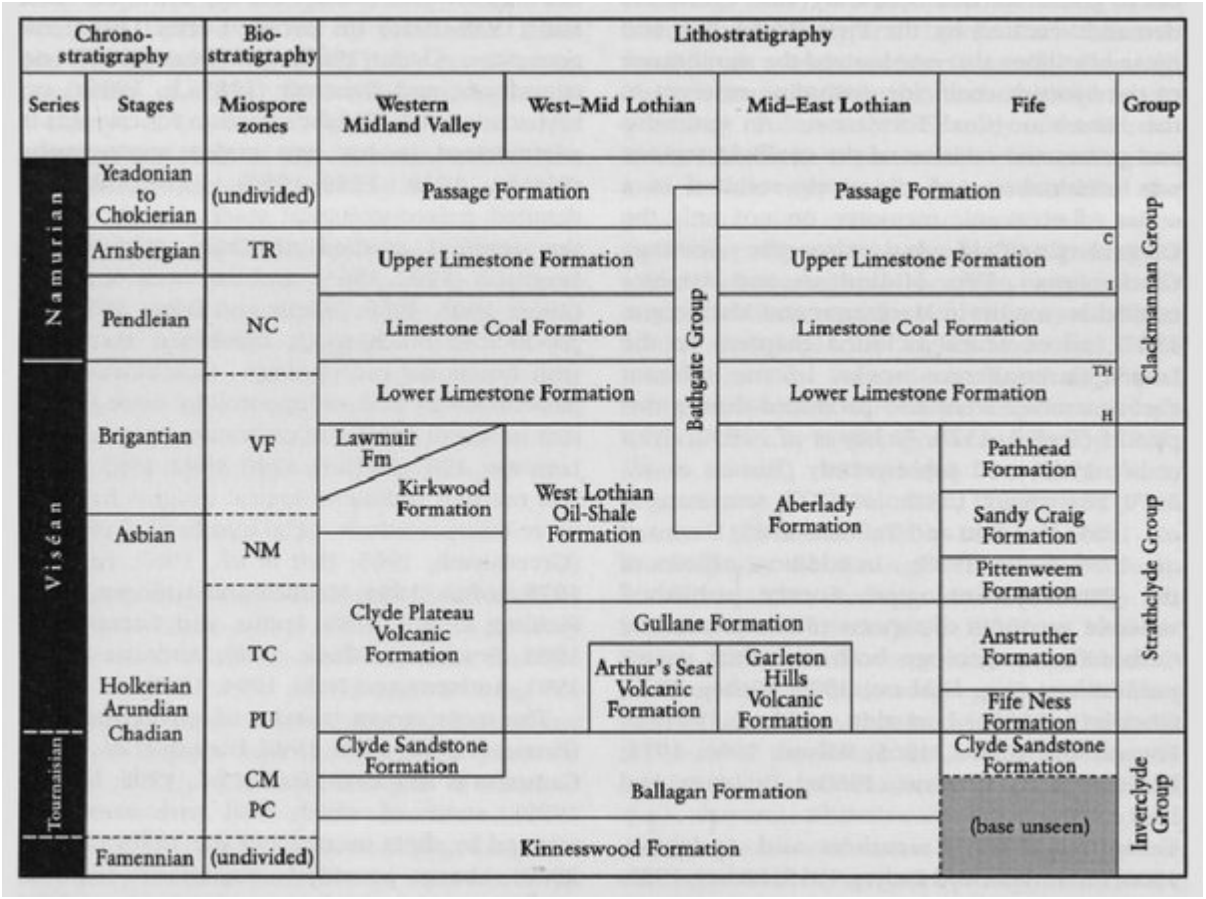
Conclusions

The Kennox Water section is highly instructive in showing important relationships between Inverclyde Group (Tournaisian), Strathclyde Group (Brigantian) and Clackmannan Group (Brigantian–Arnsbergian) successions. This extremely significant section represents the infill of a minor sedimentary basin (the Douglas Basin, see (Figure 2.1)) in the south-west of the Midland Valley. It is, however, also highly significant regionally for its representation of Lower Limestone Formation, Limestone Coal Formation and Upper Limestone Formation sequences, facies and faunas. The basal disconformity is unusual and both it and other disconformities in the succession yield invaluable evidence of phases of tectonic instability within the Douglas Basin and in the Midland Valley as a whole.

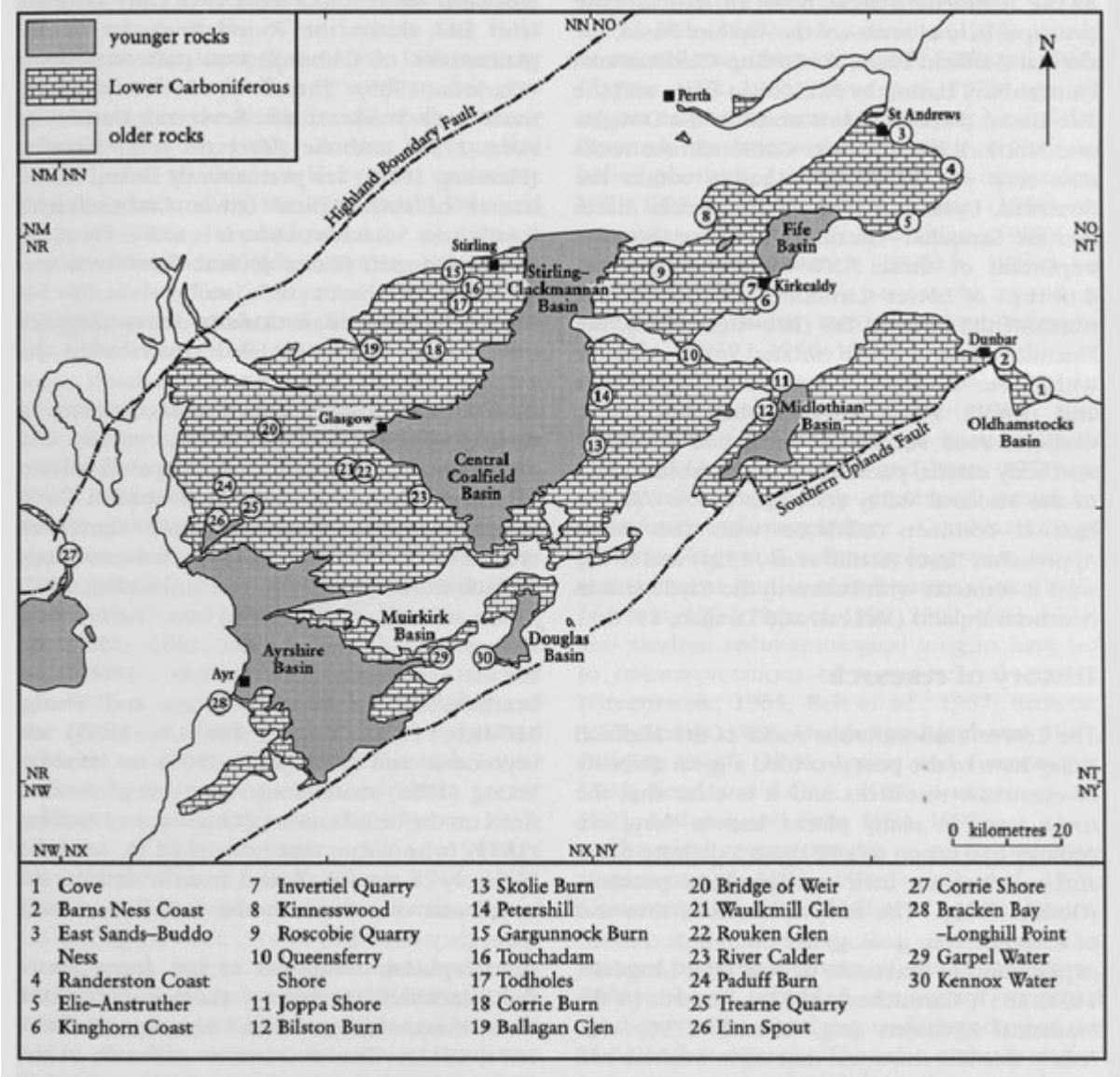
References



(Figure 2.41) Generalized sedimentary log of the Lower Carboniferous succession in the Kennox Water area. After Lumsden (1964, 1967a,b, 1971).



(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 2.1) 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).