Chapter 11 Northern England

The area dealt with in this chapter lies between the Pennine Basin and the Southern Uplands Massif (Figure 11.1). It mainly covers present day Northumberland, Durham and Cumbria, although (despite the name generally given to the area) it also extends into the southernmost parts of Scotland. It is in effect a northern continuation of the Central Province/Pennine Basin, and some authors do not distinguish between them. However, there are a number of distinctive characters of the depositional regime in these northern areas, both in the Namurian and the Westphalian, and so they have been allocated a separate chapter in this review.

One great advantage that Northern England has over the Pennine Basin, from a geological standpoint, is the better exposure. This is mostly because of the existence of coastal sites, which provide some of the best exposures of Namurian and Westphalian strata in Britain. Inland, particularly in the urbanized areas of Northumberland and Durham, exposure is less good. However, in some of the more rural and rugged areas, such as Stainmore, there are numerous stream and river sections.

The Northumberland–Durham Coalfield in particular has been of considerable economic importance in the past. In 1857, it produced nearly 16 million tons of coal, which was 24% of the total UK production (Hull, 1861). In 1929, it reached a maximum of 52.5 million tons, or 20% of the UK production (Bone and Himus, 1936). In contrast, the Cumberland Coalfield has been much less productive, its annual production in 1856 being merely 0.8 million tons, rising to 2.4 million tons in the 1920s and 1930s. The Stainmore, Midgeholm and Canonbie coalfields have never supplied much more than local needs. Today, deep mining activity in all of these areas has all but stopped, except for parts of the Northumberland–Durham Coalfield, where the 7 remaining deep-mines produced in 1990/91 8.9 million tons or 12% of the UK production (British Coal Corporation Annual Report), and where there is some potential for developing the undersea extensions of the coalfields.

Also important for the early industrialization of the area were the clay ironstones found in the Coal Measures. However, they were replaced by the Lower Carboniferous haematite ores of west Cumbria as the main supply of local ore. Refractory and brick clays have also been exploited in the area.

History of research

In addition to the areas of Upper Carboniferous outcrop discussed in detail below, there are also a number of smaller coalfields, most notably the Ingleton and Midgeholm coalfield. There are no GCR sites in these coalfields, and therefore no historical account of them will be given. However, further information on them can be found in Trotter and Hollingworth (1932) and Ford (1954).

Northumberland–Durham Coalfield

Interest in the Upper Carboniferous geology of the area seems to have started in earnest in the early 19th century. The earliest substantive account of the coalfield was given by Winch (1817). During the remainder of the century, a whole string of general accounts of its geology were published, reflecting the economic activity of the area (e.g. Buddle, 1831a, 1831b; Hall, 1854; Hurst, 1860; Lebour, 1878; Brown, 1888; Murton, 1892). Surprisingly, however, the Geological Survey were not particularly active here, at least from the point of view of the publication of memoirs (although some geological maps were issued at this time). Major memoirs dealing with parts of the coalfield did not appear until well into the 20th century, the earliest being by Carruthers *et al.* (1930) and Fowler (1936). Most recently, there have been three memoirs by Smith and Francis (1967), Day (1970) and Land (1974), which provide valuable background information on the area as a whole, as well as detailed descriptions of the specific areas that they cover. Other relatively recent general accounts of the coalfield can be found in Armstrong and Price (1954), Magraw *et al.* (1963) and Taylor *et al.* (1971).

The area has attracted considerable palaeontological interest In the 19th century, much of this was centred on the unusual deposits at Newsham, with their diverse vertebrate assemblages (e.g. Atthey, 1870, 1876, 1877; Hancock and

Atthey, 1868, 1869, 1870, 1871; Kirkby and Atthey, 1864; see Boyd, 1984 for a review of more recent literature). There was also some early palaeobotanical interest. There was a record of *in situ* tree-stumps associated with a coal seam (Wood, 1831), while the adpression record and its biostratigraphical significance was investigated by Howse (1857, 1890), Kidston (1922) and Bolton (1926). However, from a biostratigraphical point of view, by far the most important contributions were by Hopkins (1928, 1929, 1930, 1933, 1934, 1935), whose studies on the non-marine bivalves and marine bands did much to unravel the stratigraphical correlations of the coals within the coalfield, and with other areas, principally the Pennine Basin. This work was sub sequently continued by Tonks (1939), Burnett (1947) and Pollard (1966, 1969).

Another aspect of the geology of the coalfield that attracted early interest centred on the age and nature of the red beds in the upper part of the succession. Hutton (1831) and Sedgwick (1835) argued that they were Permian, but Howse (1857) used palaeobotanical evidence to show that they had to be Carboniferous in age. More recently, the coloration of the upper beds in the coalfield have been investigated by Anderson and Dunham (1953).

The extensive coastal exposures of these deposits have resulted in a number of sedimentological investigations, including Sorby's (1852) pioneering work on cross-bedding in sandstones, and Lebour and Smythe (1906) examined a sandstone-filled wash-out. However, the detailed sedimentological investigation of the coalfield has only recently been undertaken, largely through the efforts of Fielding (1984a, 1984b, 1986), Haszeldine (1981, 1983a, 1983b, 1984a) and Haszeldine and Anderton (1980).

In contrast to the Coal Measures, the Millstone Grit of this area has attracted relatively little interest, other than the Geological Survey memoirs. One of the earliest significant contributions was by Hull (1968), while some borehole evidence is covered by Mills and Hull (1969) and Neves (1969). Despite the relative paucity of evidence from here, Ramsbottom (1977) was able to incorporate it in his general mesothemic model for Millstone Grit deposition in central and Northern England.

Stainmore Coalfield

The geology of this small coalfield was discussed by Goodchild (1890) and Turner (1935). However, the most complete accounts are by Ford (1955) and Owens and Burgess (1965).

West Cumberland Coalfield

Interest in the geology of this coalfield has a long but intermittent pedigree, going back to the records of plant fossils from here by Woodward (1729; see Arber (1903) and Thomas and Cleal (1993) for a review of other early palaeobotanical records from here). Sedgwick (1835, 1836, 1842) dealt with the sandstones in the upper part of the Carboniferous, which he then erroneously considered to be Permian in age. However, an understanding of the general stratigraphy of the coalfield did not develop significantly until the end of the 19th century, and developed along two distinct lines. Firstly, there were studies by local geologists, mainly linked with coal mining activities (e.g. Kendall, 1883, 1895, 1896; Russell, 1895). Secondly, the Geological Survey commenced mapping the area in 1892 and, although the memoirs were not published for nearly another four decades (Eastwood, 1930; Eastwood *et al.,* 1931), the maps provide a valuable guide to the then known geology of the coalfield.

Arber (1903), while reviewing the palaeobotany of the coalfield, also provided a useful summary of the stratigraphical background. Later reviews have been by Taylor (1961, 1978; see also Taylor *et al.,* 1971). Most recently, Thomas and deal (1993) have returned to the problem of the stratigraphy of the sandstones in the upper part of the coalfield (known as the Whitehaven Sandstone), using palaeobotanical evidence.

Canonbie Coalfield

The first account of the geology of this coalfield was by Gibsone (1861) and Binney (1863). However, the first complete account did not appear until Peach and Home's (1903) paper describing the Geological Survey's mapping of the area. As part of this mapping project, considerable numbers of plant fossils were collected and subsequently described by Kidston

(1903a, 1903b). Most recently, memoirs dealing with the area have been produced by Barrett and Richey (1945), Lumsden *et al.* (1967) and Day (1970).

Lithostratigraphy

The Upper Carboniferous of this area falls into three groups: the Yoredales, Millstone Grit and Coal Measures. The Yoredale Group, although mainly Pendleian and Arnsbergian (and thus Lower Carboniferous in the sense used here), on the Alston Block extends up into the middle Kinderscoutian. It characteristically consists of repetitive cycles of limestones, marine shales and subordinate sandstones (Taylor *et al.,* 1971), although some thin coals and non-marine shales occur throughout the group. The numerous limestone beds in this group are individually named (e.g. Whitehouse Limestone), but there is as yet no satisfactory formational classification.

The rest of the Namurian belongs to the Millstone Grit Group. Compared with the Central Province, it is significantly condensed. For instance, in the Northumberland Trough the entire Chokierian to Yeadonian is only some 70 m thick, and in the Stainmore Trough about 140 m thick; this contrasts with 650 m for Lancashire and 935 m in the Edale Gulf (thickness taken from Ramsbottom *et al.,* 1978). It is not surprising, therefore, that only two grit formations can be recognized in Northern England, which in ascending order are known as the First Grit Formation and Second Grit Formation.

As in the Pennines, the boundary between the Millstone Grit and Coal Measures can be conveniently drawn at the base of the Subcrenatum Marine Band, thus making it coincident with the Namurian–Westphalian boundary. In the Northumberland–Durham Coalfield (also the Stainmore and Midgeholm coalfields), the entire Coal Measures Group belongs to the Productive Coal Formation. It differs somewhat from the classic development of this formation in South Wales and the Pennines, in being more arenaceous. It nevertheless contains numerous coals and mudstones, and has a similar chronostratigraphical range, and so it has been decided not to establish a separate name.

In the Cumberland and Canonbie coalfields, however, the upper parts of the Coal Measures are in quite different facies, justifying the recognition of the following formations:

Whitehaven Sandstone Formation

Stratotype: Saltom Bay, Cumberland Coalfield

Base undefined.

Characteristic facies: coarse-grained, cross-bedded sandstone, often with large shale clasts.

Chronostratigraphical range: Bolsovian.

Canonbie Red Sandstone Formation

Stratotype: River Esk, between Byreburnfoot and Canonbie Bridge, Canonbie Coalfield

Base defined: base of thick sandstone overlying the Cambriense Marine Band.

Characteristic facies: sandstones and shales, with red or purple coloration (possibly secondary).

Chronostratigraphical range: upper Bolsovian to Westphalian D.

Geological setting

The area dealt with in this chapter is in effect a northern extension of the Central Province and Pennine Basin, but which is characterized by more condensed succession, often in rather different facies. In the Viséan and lower Namurian, the area could be subdivided into a series of east–west trending basins — from south to north, the Stainmore, Northumberland and Tweed troughs (Figure 11.2). These were separated from each other by the Askrigg, Alston and Cheviot blocks, which were probably produced by the presence of basement granites (Johnson, 1984). By the mid-Namurian, the distinction between the basins had all but disappeared, but the effects of the basement granites can still be seen, in the more condensed successions present throughout Northern England.

The lower Namurian is characterized by cyclical limestone and non-marine clastic deposits, known as the Yoredales. The cyclicity is thought to have been the result of the movement of delta lobes, due to either tectonic movement or to purely sedimentary processes within the delta (Leeder and Strudwick, 1987). Within the basinal areas, the Yoredale style of deposition had disappeared by the end of the Arnsbergian, but on the blocks it persisted into the Kinderscoutian.

Most of the Upper Carboniferous part of the Namurian of Northern England is in a condensed Millstone Grit facies. The condensed sequences point to the reduced subsidence, probably resulting from the existence of basement granites. The reduced subsidence also limited the number of marine incursions that occur here. This is important, as it has meant that the marine bands are not as useful for fine stratigraphical work here as they have proved in the Central Province (see Chapter 9). There has been little detailed sedimentological work on the Millstone Grit of this area, but it is likely that the grits were the result of sheet deltas, similar to those seen in the Central Province.

The Westphalian sees a change to delta-plain conditions. It clearly represents a continuation of the delta-complex that formed the deposits of the Pennine Basin; the sedimentological studies by Fielding (1984a, 1984b, 1986) have demonstrated that, especially with the flood-plain facies-associations, there is an essential similarity with coeval deposits in the central part of the Pennine Basin (e.g. Elliott, 1968, 1969). However, much of the Coal Measures of Northern England have a much higher proportion of sandstone than their equivalents further south. Furthermore, recent sedimentological work suggests that many of these sandstones were formed in relatively high-energy, braided channels, that cut down into the flood-plain deposits, and were thus probably in a more proximal position in the delta-complex (Haszeldine and Anderton, 1980). A more proximal position is also supported by the reduced number of marine bands present and the fact that, where they do occur, they are often little more than *Lingula* bands.

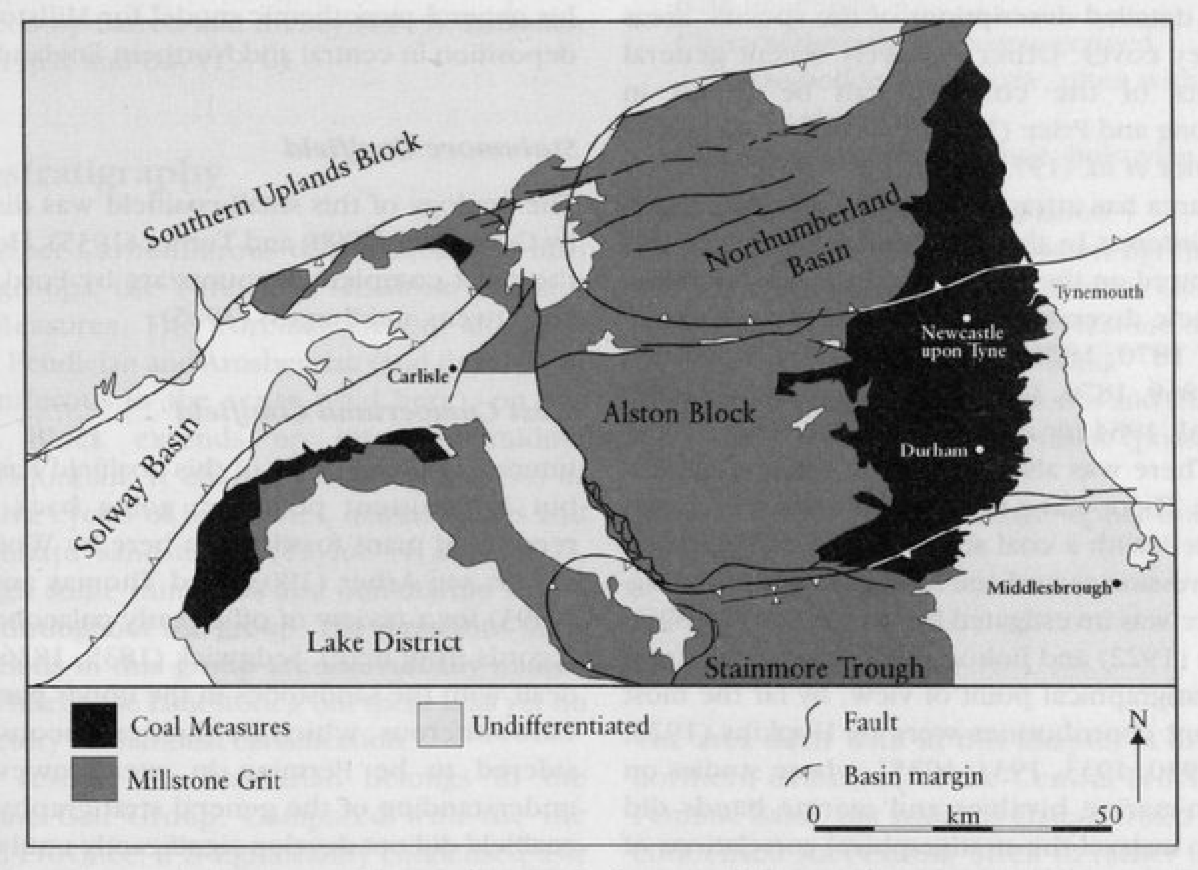
Higher in the Westphalian, sandstones form an even higher proportion of the succession, and coal virtually disappears (e.g. Whitehaven and Canonbie Red formations). These presumably represent fluvio-deltaic deposits derived from the Southern Uplands Block to the north, although they have not yet been subjected to detailed sedimentological investigation.

GCR site coverage

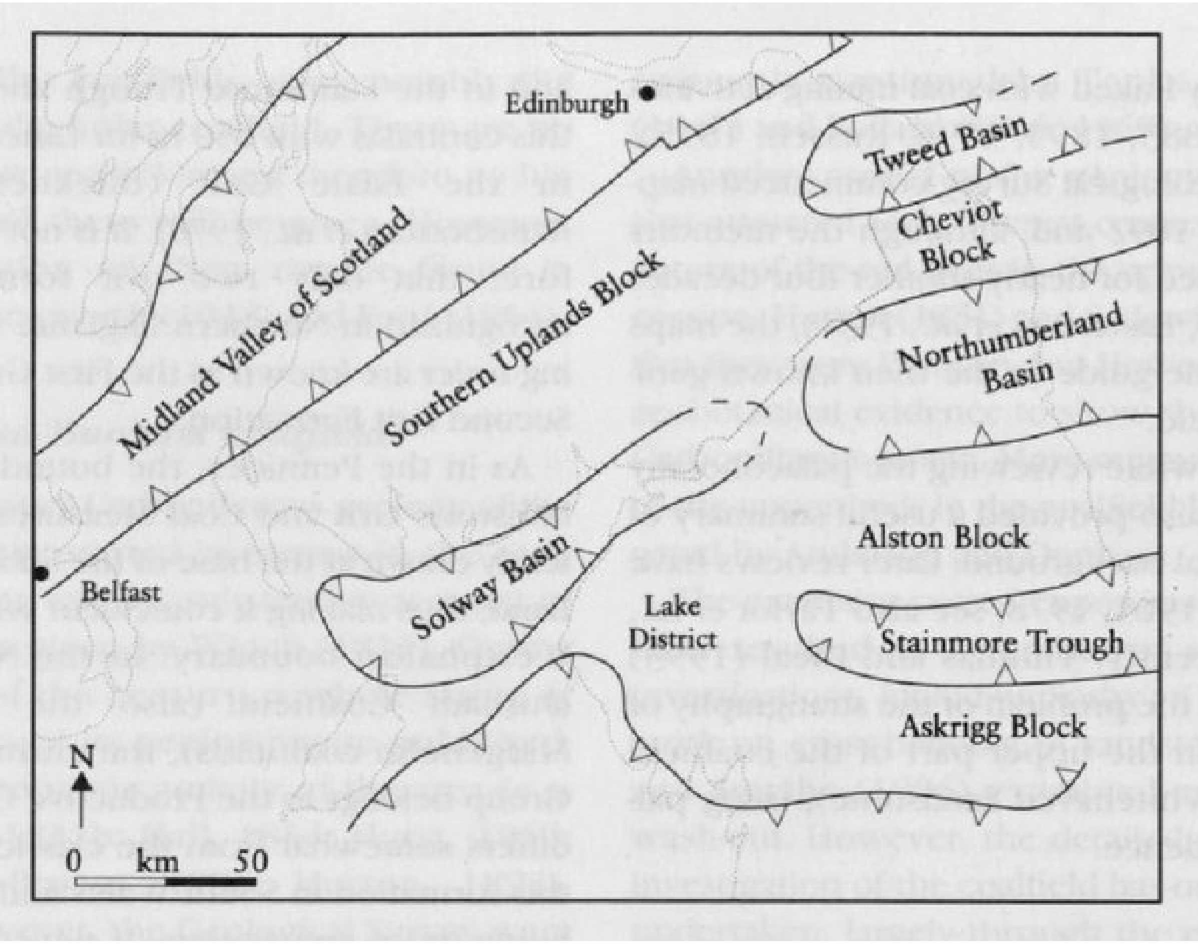
The core of the coverage lies in the coastal sites, that demonstrate long successions: Howick to Seaton Point for the Millstone Grit, Tynemouth to Seaton Sluice, and Cresswell and Newbiggin Shore for the Productive Coal Formation, Saltom Bay for the Whitehaven Sandstone and Byre Burn. In view of its biostratigraphical significance, particularly for palynological studies, a section through the Millstone Grit of the Stainmore Trough has also been included (Mousegill Beck).

In addition to these, Crag Gill was selected to demonstrate the persistence of the Yoredales on the Alston Block. Wear River Bank was chosen for its considerable palaeontological interest, yielding remains including insects, xiphosurids and fish. Finally, Jockie's Syke was chosen for showing the Canonbie Red Sandstone Formation, as well as being the only British site still yielding middle Westphalian D plant fossils.

References



(Figure 11.1) Upper Carboniferous of the Northern England area (including southernmost Scotland). Based on Taylor et al (1971, fig. 13).



(Figure 11.2) Distribution of main basins in Northern England in the Late Carboniferous. Based on Johnson (1984, fig. 1).