British Upper Carboniferous Stratigraphy

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Chapter 6

Bristol–Somerset Basin

This basin has been estimated to be about 600 km in area (Figure 6.1), and thus one of the most important developments of Upper Carboniferous strata in southern Britain (Moore and Trueman, 1942). However, four-fifths of it is covered by Mesozoic strata, often at some depth. This has limited the degree to which the coal has been exploited; its annual productivity reached a maximum of only about 1.5 million tons between the world wars (Bone and Himus, 1936), and the last pit closed over 20 years ago.

Even where the Upper Carboniferous does crop out at surface, it is mostly covered by superficial deposits. Consequently, there is very little natural exposure except along the steep sides of the Avon Valley, and so direct observations of the surface geology can only be made at man-made exposures such as railway cuttings and claypits. This has made it difficult to develop a coherent network of GCR sites to demonstrate the Upper Carboniferous geology of the area.

History of research

The earliest attempt to summarize the geology of the Bristol-Somerset Coalfield was by Buckland and Conybeare (1824), who brought together the main pieces of stratigraphical and structural evidence then available. The principal problem at this time was the tectonic complexity of the area, which made it difficult to establish a uniform stratigraphical scheme throughout the coalfield. This problem was further investigated by officers of the Geological Survey (Woodward, 1876). In addition, local geologists affiliated with the coal companies were providing much useful data, the names of McMurtrie and Cossham standing out as being particularly important (McMurtrie, 1867, 1869, 1890, 1901; Greenwell and McMurtrie, 1864; Cossham, 1879, 1885).

The second phase of research on the coalfield was undertaken in the 1930s and 1940s at the University of Bristol, co-ordinated largely by A.E. Trueman. Although he was only professor at Bristol for four years, Trueman, together with his then research student L.R. Moore, instigated a fundamental revision of the geology of the coalfield. They brought together a wealth of new information derived from the collieries, and integrated it with the then new biostratigraphical techniques involving plant and non-marine bivalve fossils. The resulting papers still provide some of the most detailed published descriptions of the stratigraphy and structure of this coalfield (Moore, 1938, 1941; Moore and Trueman, 1937, 1939, 1942).

Most recently, the area has been investigated by Kellaway, on behalf of the British Geological Survey. Until recently, his most important publication was a paper dealing with the upper Westphalian part of the sequence here and its relationship to other, nearby coalfields, such as South Wales and Warwickshire (Kellaway, 1970). He also published a number of summaries of the geology of the coalfield (Kellaway and Welch, 1948, and in Curtis *et al.*, 1955). The strength of his work lay in the detailed mapping for which he was responsible, and the lithostratigraphical correlations that he established. Recently, the British Geological Survey Memoir for the coalfield has been published (Kellaway and Welch, 1993), which is in many ways the culmination of Kellaway's works.

In addition to the stratigraphical work that has been undertaken in the coalfield, it is perhaps worth mentioning briefly its palaeontology. The area has long been renowned for yielding finely preserved plant adpressions, some of which were featured in the pioneering palaeobotanical studies by Sternberg (1820-1838) and Brongniart (1828-1838), apparently supplied by Buckland. Papers dealing with aspects of the palaeobotany have been written by Kidston (1887), Lillie (1910), Crookall (1925, 1929) and Thomas and Cleal (1994), and many specimens were figured in Kidston's (1923-1925) memoir on the British Coal Measures plant fossils. Recent discoveries have also demonstrated the importance of this area for animal fossils, particularly insects and other arthropods (Jarzembowski, 1989).

Lithostratigraphy

The lithostratigraphical classification of these strata broadly follows that of Kellaway (1967, 1970). The Namurian part of the sequence, which is mainly known from boreholes, is referred to as the Quartzitic Sandstone Formation or 'Group'. This is overlain by a thick sequence of Coal Measures, which includes a lower, coal-bearing interval (the Productive Coal Formation), a thick, mainly arenaceous interval (Downend and Mangotsfield formations), and an upper, coal-bearing interval (Farrington, Barren Red, Radstock and Publow formations). A generalized sequence of the Bristol-Somerset Coal Measures is shown in Figure 6.2.

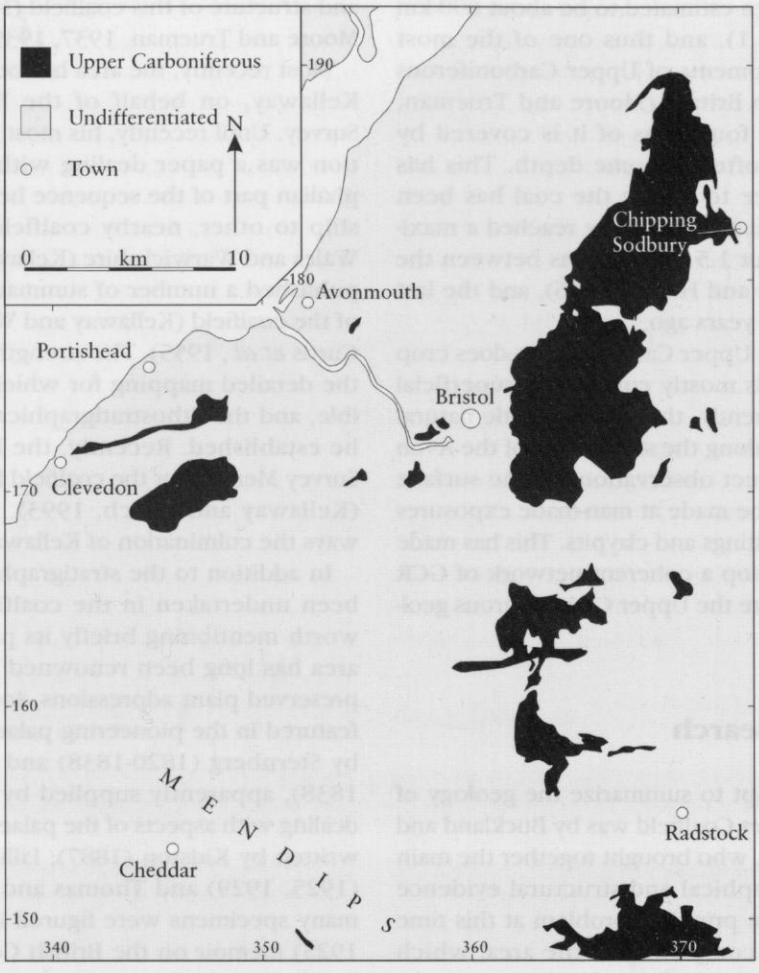

Figure 6.1 Map of the Bristol–Somerset Coalfield. After Kellaway and Welch (1993).

Quartzitic Sandstone Formation
- Stratotype: Ashton Park Borehole (Kellaway, 1967) – no suitable surface exposure currently available.
- Base defined: base of lowest Namurian sandstone.
- Characteristic facies: massive sandstones.
- Chronostratigraphical range: Pendleian to Yeadonian.

Productive Coal Formation
- Defined in South Wales (see Chapter 4)
- Chronostratigraphical range: Langsettian to Bolsovian.
- Comments: In the southern part of the basin, the upper part of the Productive Coal Formation is significantly more arenaceous, and has resulted in the recognition of two discrete members, the Vobster and New Rock 'groups' (Moore and Trueman, 1937, 1942). However, this subdivision cannot be recognized elsewhere in the coalfield.

Downend Formation
- Stratotype: Bickley Wood
- Base defined: the base of the first massive sandstone or conglomerate above the Cambriense Marine Band.
- Characteristic facies: lenticular quartz-conglomerates and red-measures.
- Chronostratigraphical range: upper Bolsovian to lower Westphalian D.

Mangotsfield Formation
- Stratotype: Winterbourne Railway Cutting
- Base defined: Mangotsfield group of coals.
- Characteristic facies: cross-bedded, Pennant-type sandstones.
- Chronostratigraphical range: Westphalian D.

Farrington Formation
Stratotype: undefined (no surface outcrops available).
Base defined: base of No.9 Coal of Radstock.
Characteristic facies: grey, coal-bearing measures.
Chronostratigraphical range: upper Westphalian D.

Barren Red Formation
Stratotype: undefined (no surface outcrops available).
Base defined: base of Rock Coal of Radstock.
Characteristic facies: red mudstones and siltstones.
Chronostratigraphical range: upper Westphalian D.

Radstock Formation
Stratotype: undefined (no surface outcrops available).
Base defined: Nine Inch Coal of Radstock.
Characteristic facies: grey, coal-bearing measures.

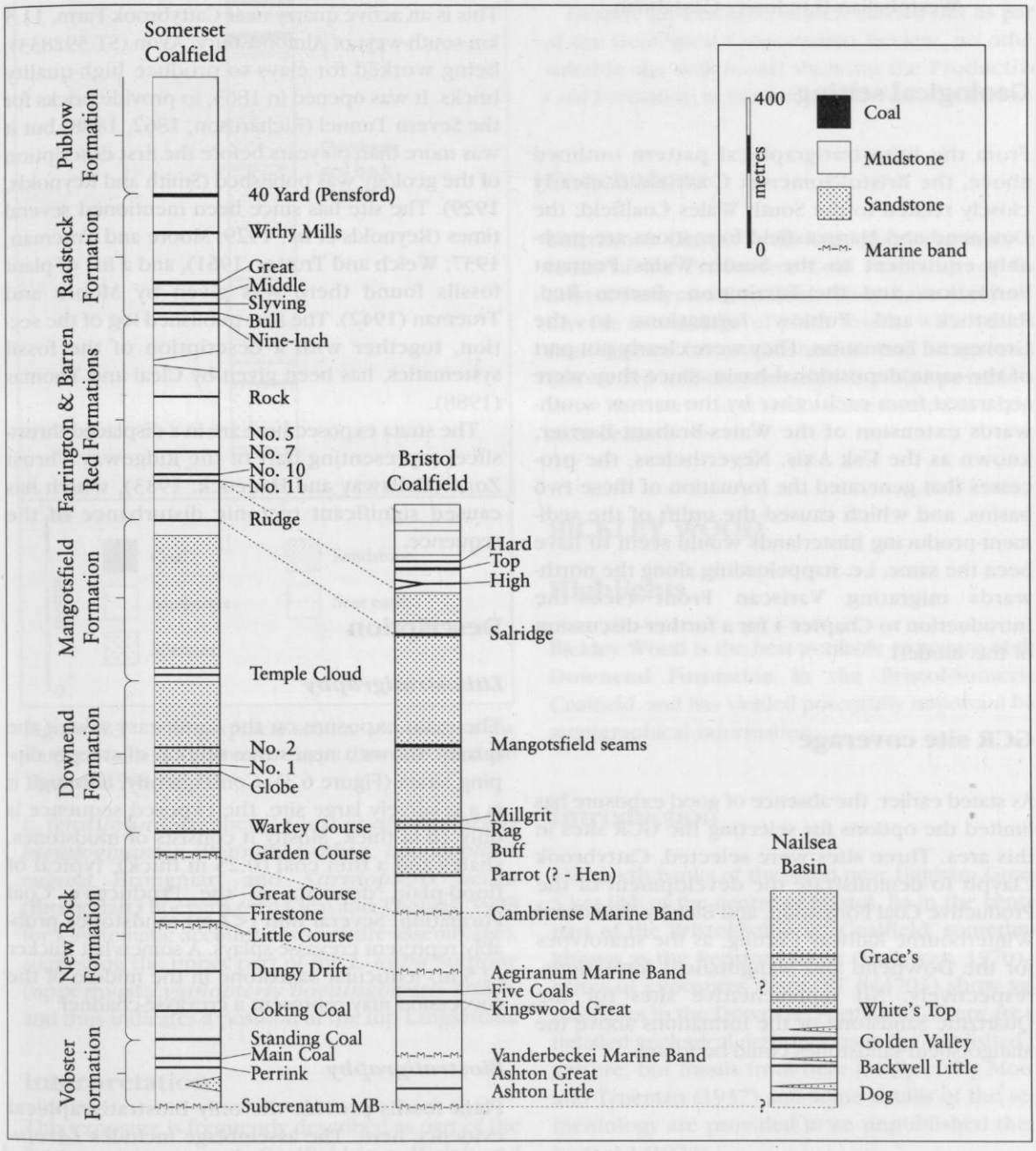

Figure 6.2 Generalized Upper Carboniferous sequence in the Bristol–Somerset Coalfield.

Chronostratigraphical range: upper Westphalian D.

Publow Formation

Stratotype: Hursley Hill Borehole (no surface exposures available).

Base defined: Forty Yard Coal of Pensford.

Characteristic facies: grey mudstones and sandstones, sometimes developing a reddish coloration, and with some thin coals.

Chronostratigraphical range: upper Westphalian D to lower Cantabrian.

Geological setting

From the lithostratigraphical pattern outlined above, the Bristol-Somerset Coalfield is clearly closely related to the South Wales Coalfield; the Downend and Mangotsfield formations are probably equivalent to the South Wales Pennant Formation, and the Farrington, Barren Red, Radstock and Publow formations to the Grovesend Formation. They were clearly not part of the same depositional basin, since they were separated from each other by the narrow southwards extension of the Wales-Brabant Barrier, known as the Usk Axis. Nevertheless, the processes that generated the formation of these two basins, and which caused the uplift of the sediment-producing hinterlands would seem to have been the same, i.e. nappeloading along the northwards migrating Variscan Front (see the Introduction to Chapter 4 for a further discussion of this model).

GCR site coverage

As stated earlier, the absence of good exposure has limited the options for selecting the GCR sites in this area. Three sites were selected, Cattybrook Claypit to demonstrate the development of the Productive Coal Formation, and Bickley Wood and Winterbourne Railway Cutting, as the stratotypes for the Downend and Mangotsfield formations, respectively. No representative sites for the Quartzitic Sandstone or the formations above the Mangotsfield sandstones could be found.

CATTYBROOK CLAYPIT

Highlights

Cattybrook Claypit is the only good exposure of Productive Coal Formation of the Bristol-Somerset Coalfield.

Introduction

This is an active quarry near Cattybrook Farm, 11.5 km south-west of Almondsbury, Avon (ST 592833), being worked for clays to produce high-quality bricks. It was opened in 1863, to provide bricks for the Severn Tunnel (Richardson, 1862, 1888) but it was more than 60 years before the first description of the geology was published (Smith and Reynolds, 1929). The site has since been mentioned several times (Reynolds *et al.*, 1929; Moore and Trueman, 1937; Welch and Trotter, 1961), and a list of plant fossils found there was given by Moore and Trueman (1942). The first published log of the section, together with a description of the fossil systematics, has been given by Cleal and Thomas (1988).

The strata exposed here are in a displaced thrust-slice, representing part of the Ridgeway Thrust Zone (Kellaway and Hancock, 1983), which has caused significant tectonic disturbance of the sequence.

Description

Lithostratigraphy

The main exposure on the south-east side of the quarry, shows a near-strike section of steeply dipping strata (Figure 6.3). Consequently, although it is a relatively large site, the exposed sequence is only 10 m thick. Mostly it consists of mudstones, shales and a thin coal (0.25 m thick), typical of flood-plain deposits of the Productive Coal Formation. Several thin (<2 m) sandstones probably represent crevasse-splays. A somewhat thicker (2.5 m) lenticular sandstone in the middle of the succession may represent a crevasse-channel.

Biostratigraphy

Plant fossils provide the only biostratigraphical evidence here. The assemblage includes *Laveineopteris loshii* (Brongniart) Cleal *et al.*,

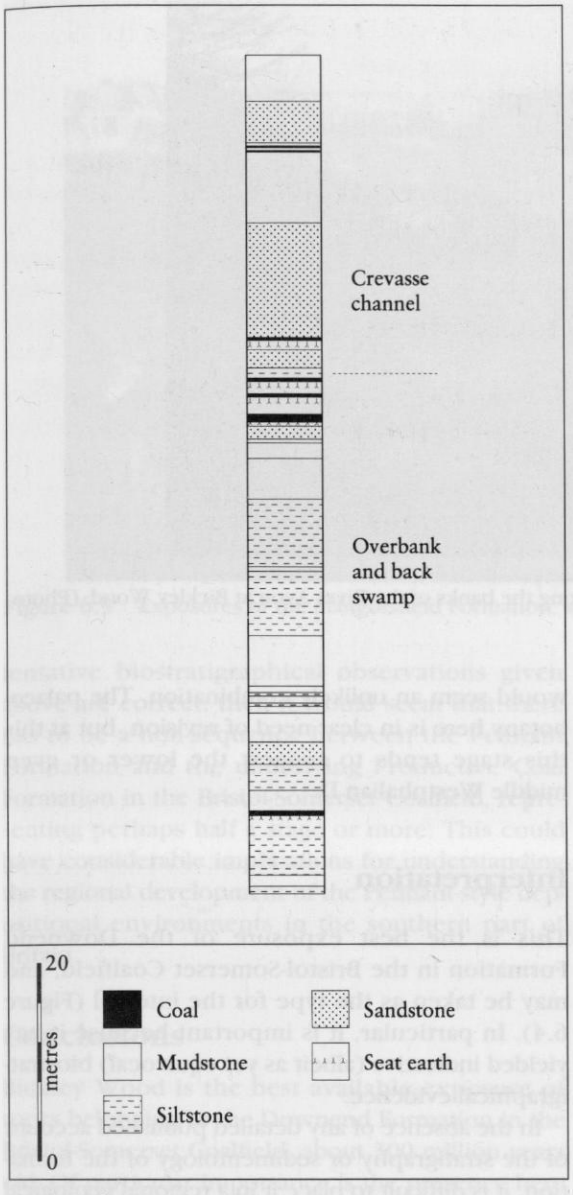

Figure 6.3 Stratigraphical section exposed on the south-east side of Cattybrook Claypit. Based on Cleal and Thomas (1988, fig. 2).

L. tenuifolia (Sternberg) Cleal *et al.*, *Paripteris pseudogigantea* (Potonié) Gothan, *Lonchopteris rugosa* Brongniart and *Karinopteris acuta* (Brongniart) Boersma (see Cleal and Thomas, 1988 for a systematic account of the entire assemblage), suggesting the upper part of the *L. loshii* Subzone (uppermost *Lyginopteris hoeninghausii* Zone), and thus indicates a position in the top Langsettian.

Interpretation

This exposure is frequently described as part of the Severn or Avonmouth Coalfield (e.g. Welch and Trotter, 1961). However, there is otherwise no evidence of strata below the upper Westphalian D in this coalfield (Cleal, 1986). Rather, the strata exposed are probably part of an allochthonous thrust slice, which originated in the Bristol-Somerset Coalfield. Assuming this is correct, the Cattybrook sequence must represent strata just below the Vanderbeckei Marine Band in the Bristol-Somerset Coalfield, and the thick coal reported in the neighbouring Cattybrook railway cutting (Jones, 1882) is probably an equivalent of the Red Ash Seam.

Despite an extensive search carried out as part of the Geological Conservation Review, no other suitable site was found showing the Productive Coal Formation in the Bristol-Somerset Coalfield.

Conclusions

Cattybrook Claypit is the only good exposure of rocks of the Productive Coal Formation of the Bristol-Somerset Coalfield. They have yielded a diverse assemblage of plant fossils, which allow their age to be established as late Langsettian (about 313 million years old). It is also possible to show here how these rocks were formed in a large river-delta.

BICKLEY WOOD

Highlights

Bickley Wood is the best available exposure of the Downend Formation in the Bristol-Somerset Coalfield, and has yielded potentially important biostratigraphical information.

Introduction

The north banks of the Avon near Hanham Green, 5 km ESE of the centre of Bristol, lie in the central part of the Bristol-Somerset Coalfield, sometimes known as the Pensford Basin (Kellaway, 1970). A series of exposures there (ST 644703) show various facies in the Downend Formation. There are no detailed geological descriptions in the published literature, but fossils from here are listed by Moore and Trueman (1937) and some details of the sedimentology are provided in an unpublished thesis by Stead (1974).

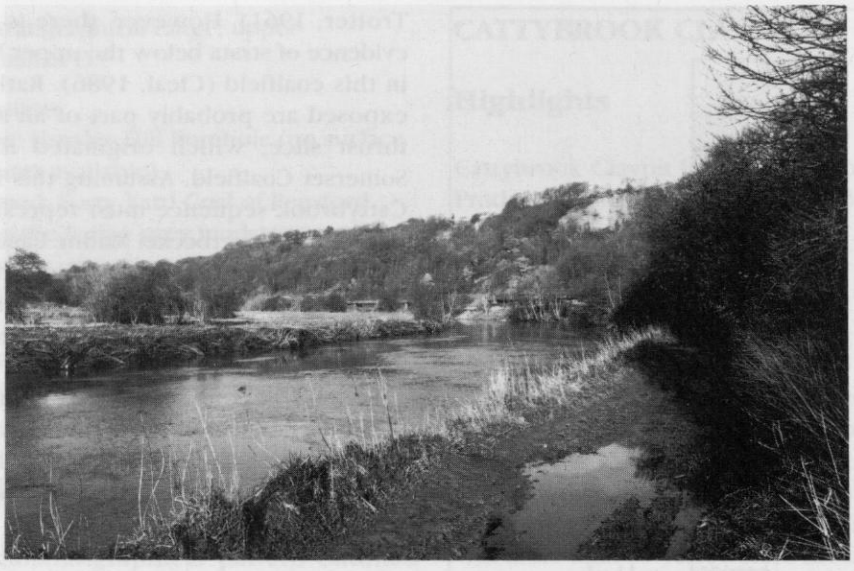

Figure 6.4 Exposures of the Downend Formation, seen along the banks of the River Avon at Bickley Wood. (Photo: C.J. Cleal.)

Description

Lithostratigraphy

A coherent lithostratigraphical log has yet to be constructed from the various separate exposures present in this site. However, it is possible to see here most of the lithofacies characteristic of the lower Pennant Formation of the Bristol-Somerset Coalfield, including massive, cross-bedded sandstones and lenticular quartz-conglomerates. There are also some thin shales, which have yielded fossils (see below).

Biostratigraphy

Moore and Trueman (1937) reported that plant and animal fossils had been collected from shales exposed near Elm Tree Inn at Hanham Green. A species list was not given, but it was claimed that the assemblage was similar to that collected from the other side of the river at Chandos Lodge. The latter included non-marine bivalves *A. phillipsi*, which suggest the upper Bolsovian to Cantabrian.

The list of plant fossils given is difficult to assess and may include some misidentifications. The occurrence together of elements typical of lower to middle Wesphalian assemblages *Laveineopteris tenuifolia* (Sternberg) Cleal *et al.*, *Neuropteris* cf. *obliqua* (Brongniart) Zeiller, *Paripteris* cf. *linguaefolia* (Bertrand) Laveine and typical Westphalian D elements *N. ovata* Hoffmann, *N. flexuosa* Sternberg, *Ptychocarpus unitus* (Brongniart) Weiss would seem an unlikely combination. The palaeobotany here is in clear need of revision, but at this this stage tends to suggest the lower or even middle Westphalian D.

Interpretation

This is the best exposure of the Downend Formation in the Bristol-Somerset Coalfield, and may be taken as the type for the interval (Figure 6.4). In particular, it is important because it has yielded indicative (albeit as yet equivocal) biostratigraphical evidence.

In the absence of any detailed published account of the stratigraphy or sedimentology of the formation, it is difficult to place it in a regional geological setting. As it lies only a short distance above the Cambriense Marine Band, there would seem to be an obvious comparison with the lower part of the Pennant Formation in the southern part of the South Wales Coalfield (Llynfi Member). However, the evidence of the plant fossils suggests a rather higher stratigraphical position, nearer to that of the Brithdir or even the Hughes members in South Wales. Unfortunately, the position of the above mentioned fossiliferous shales within the Downend Formation is not clearly stated; Moore and Trueman (1937) merely recorded that they are at a higher level than the shales exposed at St Anne's Park, which themselves are not far above the base of the 'Pennant Series'. If they are not significantly high in the Downend Formation, however, and the

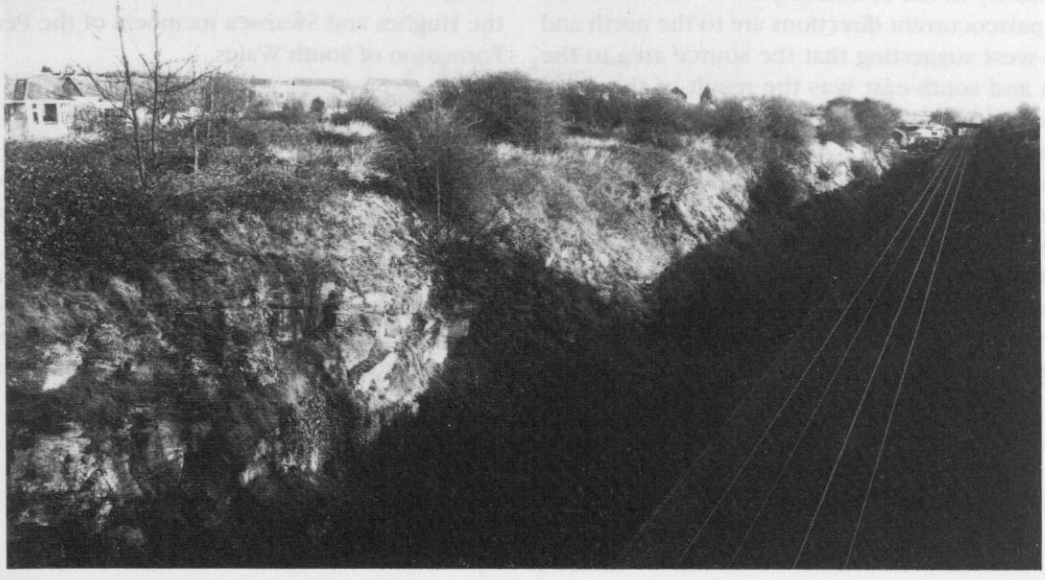

Figure 6.5 Exposures of the Mangotsfield Formation, seen at Winterbourne Railway Cutting. (Photo: C.J. Cleal.)

tentative biostratigraphical observations given above are correct, then it would seem that there has to be a non-sequence between the Pennant Formation and the underlying Productive Coal Formation in the Bristol-Somerset Coalfield, representing perhaps half a stage or more. This could have considerable implications for understanding the regional development of the Pennant-style depositional environments in the southern part of Britain.

Conclusions

Bickley Wood is the best available exposure of rocks belonging to the Downend Formation in the Bristol-Somerset Coalfield, about 300 million years old. Of particular importance is the presence here of fossils, normally very rare in this formation, that allow an indication of the stratigraphical position of these rocks relative to the rest of the coalfield to be established.

WINTERBOURNE RAILWAY CUTTING

Highlights

Winterbourne Railway Cutting shows the best exposure of the Mangotsfield Formation in the Bristol-Somerset Coalfield. It is particularly important for understanding the development of the major fluvial system draining from the uplifting hinterland to the south, which affected much of south-west Britain.

Introduction

This deep cutting on either side of the bridge taking Dragon Road over the main London-Cardiff railway line, Winterbourne, Avon (ST 651799) exposes part of the Mangotsfield Formation in the Coalpit Heath 'basin' north of Bristol. The only account of the geology is in an unpublished thesis by Stead (1974).

Description

The exposed sequence here is about 200 m thick. It consists of alternating thick and thin beds of sandstone (i.e. greater than and less than about 1 m thick), both bed-types being strongly cross-bedded. They often weather to a distinctive red to purple colour, suggesting a high iron content. According to Stead (1974), the sedimentology indicates deposition in a north-west-flowing fluvial system. From both their lithological character and field relations, the strata clearly belong to the Mangotsfield Formation.

Interpretation

This is by far the most extensive exposure of the Mangotsfield Formation in the Bristol-Somerset Coalfield, and may be taken as the type for the interval (Figure 6.5). Lithologically, it compares closely with the South Wales Pennant Formation,

particularly in the southern part of that coalfield. Also, palaeocurrent directions are to the north and north-west suggesting that the source area to the south and south-east was the result of the same nappe-generated uplift that produced the South Wales sandstones.

There is no direct biostratigraphical evidence available here, and fossils are generally rare throughout the formation. However, Moore and Trueman (1937) report plant fossils from near the base of the formation which clearly indicate the Westphalian D, possibly the middle Westphalian D. If the latter proves to be the case, then the Mangotsfield Formation will be broadly coeval with the Hughes and Swansea members of the Pennant Formation of South Wales.

Conclusions

Winterbourne Railway Cutting is the best exposure of rocks of the Mangotsfield Formation in the Bristol-Somerset Coalfield, about 300 million years old. It is particularly important for understanding the development of the major river system draining from the uplifting area to the south, which affected much of south-west Britain at this time.