

Chapter 6

Bristol, Mendips and Forest of Dean

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Carboniferous rocks within this region occur in a series of inliers, many occurring in the cores of periclinal and anticlinal structures. The Tournaisian and Visean strata comprise ramp carbonate successions (Avon and Pembroke Limestone groups), which show similarities with equivalent strata to the west in South Wales (Chapter 5). The main outcrops, broadly from south to north, are the Cannington Park inlier and Mendips and at Weston-super-Mare, Broadfield Down, Bristol and Avon, Cromhall and Chepstow to Monmouth (Fig. 6.1). Namurian strata are present only in the south of the region, in the Bristol and Somerset coalfields. Little information is available on the nature of these strata, though they show some similarities to the fluvial and deltaic successions of the Marros Group of South Wales (Chapter 5). Westphalian strata are present in all the coalfields, broadly from south to north, the Somerset, Bristol, Severn, Forest of Dean and Newent coalfields (Fig. 6.1). Fluvio-lacustrine deposits (South Wales Coal Measures Group) are present only in the Somerset, Bristol and the south-eastern part of the Nailsea coalfields. These coalfields are laterally contiguous beneath Mesozoic strata. Deposition was also probably laterally contiguous with the concealed Berkshire Coalfield (Chapter 7). Lateral continuity with the South Wales Coalfield (Chapter 5) is not possible to demonstrate. Strata of this facies are absent from the Newent, Forest of Dean and Severn coalfields and the Cannington Park inlier along the axis of the syn-Westphalian Usk Anticline. It is not clear if the Coal Measures were deposited and subsequently removed by erosion during late Bolsovian to early Asturian deformation or were never deposited at all. Although thinning of the succession can be demonstrated in the Nailsea Coalfield, there is no facies change to indicate passage towards a growth anticline. A Westphalian to Stephanian alluvial succession of Pennant facies (Warwickshire Group) occurs within all six coalfields, though proved Stephanian strata are restricted to the Somerset and Forest of Dean coalfields. Deposition was probably laterally contiguous with the South Wales Coalfield (Chapter 5) and the concealed Oxfordshire and Berkshire coalfields (Chapter 7).

The lithostratigraphical nomenclature used in this chapter is that of Waters *et al.* (2009).

Tournaisian

Tournaisian strata extend across the region, consisting of a lower mudstone-dominated ramp succession, the Avon Group (former Lower Limestone Shales), overlain by a limestone-dominated succession, the Black Rock Limestone Subgroup, which ranges up to Chadian age.

Over most of the region, the Avon Group has not been divided. However, in the Monmouth and Chepstow area (Fig. 2, Col.5) the threefold division used in South Wales (see Chapter 5) has been applied. This comprises an oolitic/skeletal shoal unit, the Castell Coch Limestone Formation, separating a lower Tongwynlais Formation from an upper Cwmyniscoy Mudstone Formation (Burchette 1987). As in South Wales, the Tongwynlais Formation fails rapidly northwards, the Castell Coch Limestone eventually coming to rest disconformably on the Devonian Old Red Sandstone. In the Avon Gorge area (Fig. 6.2, Col. 4) the lowermost part of the Avon

Group, the Shirehampton Formation, contains a restricted marine or brackish fauna including *Lingula*, *Modiolus* and *Sanguinolites* (Kellaway & Welch 1993). Palynomorphs from the basal 4 m of the most distal part of the Avon Group in the Knap Farm Borehole, in the Cannington Park inlier (Fig. 6.2, Col. 1), indicate a late Devonian age (LN Subzone) (Mitchell *et al.* 1982). Samples from the overlying 31 m contain miospores of the VI Biozone (Mitchell *et al.* 1982) of early Tournaisian age ^{^1}. The upper part of the group contains conodont faunas of the *Siphonodella* Biozone ^{O2} (Mitchell *et al.* 1982). Miospore assemblages obtained by Utting & Neves (1970) from the middle part of the Shirehampton Formation in the Bristol area have been reinterpreted as being of VI Biozone age ^{^1} by Clayton *et al.* (1986a). In the eastern Mendips, miospore assemblages from the upper two thirds of the Avon Group have been obtained by Higgs & Clayton (1984). The uppermost 70m belong to the PC Biozone, whereas the underlying 20m belong to the BP Biozone (Fig 6.2, Col. 2 ^{^1}).

In the most distal setting of the Knap Farm Borehole (Fig. 6.2, Col. 1), all but the lowermost part of the Black Rock Limestone Subgroup spans the mid Tournaisian *Polygnathus communis carina* Biozone (Mitchell *et al.* 1982). The deep water index conodont *Dollymae bouckaerti* is present in the upper part of the subgroup ^{O3}. The subgroup also spans the *Zaphrentites delanouei* and *Caninophyllum patulum* Assemblage coral biozones (Mitchell *et al.* 1982). The upper part of the overlying Cannington Reef Limestone spans the *Scaliognathus anchoralis* Biozone and contains the deep water index conodont *Eotaphrus burlingtonensis* ^{O4} (Mitchell *et al.* 1982), indicating a mid to late Tournaisian age. In the Weston-super-Mare area (Fig. 6.2, Col. 3) the oldest beds of the Black Rock Limestone Subgroup are assigned to the *Siphonodella* Conodont Biozone, due to the presence of *Patrognathus variabilis*, and the *Zaphrentites delanouei* Assemblage Biozone ^{O*1} (Whittaker & Green 1983), of early Courceyan age. The limestone beds immediately below and above the Middle Hope Volcanic Member are attributed to the *Polygnathus communis carina* Conodont Biozone and the *Caninophyllum patulum* Assemblage Biozone ^{O*2} (Whittaker & Green 1983) of late Courceyan age. The upper part of the subgroup includes limestones of the conodont *Scaliognathus anchoralis* Biozone ^{O3} (Whittaker & Green 1983) of latest Courceyan age. The same coral assemblage biozones are recorded by Mitchell & Green (in Green & Welch 1965, p 180-187) from the Burrington area of the eastern Mendips ^{*2} (Fig. 6.2, Col. 2) and by Mitchell (1972) from the Avon Gorge ^{*2} (Col. 4).

Visean

Visean strata, assigned to the Pembroke Limestone Group, extend across the region. In the Weston-super-Mare area (Fig. 6.2, Col. 3) the entrance of *Mestognathus beckmanni* in the uppermost part of the Black Rock Limestone Subgroup is taken as the base of the Visean. It is accompanied by corals of the *Siphonophyllia cylindrica* (s.s.) Assemblage Biozone ^{O*4} (Whittaker & Green 1983), of Chadian age. This assemblage biozone is also recorded in the eastern Mendips ^{O*3} (Fig. 6.2, Col. 2) by Mitchell & Green (in Green & Welch 1965) but appears to be absent from the Avon Gorge (Mitchell 1972), as a result of intra-Chadian emergence (Faulkner *et al.* 1990). In the Knap Farm Borehole, in the Cannington inlier (Fig. 6.2, Col. 1) the conodont *M. beckmanni* is absent but the appearance of *Gnathodus homopunctatus* within the middle part of the Cynwir Cherty Limestone ^{O5} (Mitchell *et al.* 1982), suggests a Chadian age. Foraminiferal assemblages from the middle and upper parts of the

formation indicate an early Arundian (V1b) and late Arundian (V2a) age ⁰⁶, respectively (Mitchell *et al.* 1982).

The Gully Oolite Formation is generally poorly fossiliferous, but at Middle Hope in the Weston-super-Mare area (Fig. 6.2, Col. 3) the basal crinoidal and oolitic beds include fauna of Chadian age, notably the brachiopod *Levitusia humerosa* ^{*5} (Mitchell 1972). The top of the formation is taken at a major palaeokarstic surface.

The peritidal micritic limestones and mudstones of the Caswell Bay Mudstone Formation lack diagnostic fauna, but are regarded as Arundian on regional sedimentological grounds (Riding & Wright 1981). The overlying High Tor Limestone Formation at Weston-super-Mare (Fig. 6.2, Col. 3) includes a basal bed with *Palaeosmia murchisoni* and abundant double-walled *Koninckopora*, indicating an early Arundian age ^{*6}. A coral bed 10 to 11 m above the base of the formation has a rich Arundian fauna (Whittaker & Green 1983). The upper part of the formation in the Weston-super-Mare area includes the diagnostic chonetid *Delepinea carinata* (Whittaker & Green 1983), also recorded about 46 to 61 m above the base of the Burrington Oolite Subgroup in the Mendips (Kellaway & Welch 1993; Fig. 6.2, Col. 2 ⁰⁴). Algae and foraminifers from Weston-super-Mare ⁰⁷ (Whittaker & Green 1983; Fig. 6.2, Col. 3) and the Avon Gorge ⁰³ (George *et al.* 1976; Col. 4) indicate a late Arundian (V_{2a}) age for the Goblin Combe Oolite Formation. The Arundian succession of the Monmouth/Chepstow area (Fig. 6.2, Col. 5) is represented by the peritidal limestones of the Llanelly Formation.

The Holkerian succession is dominated by the Clifton Down Limestone Formation (Fig. 6.2, Cols. 2, 3 & 4; Kellaway & Welch 1993). The Cromhall (former Drybrook) Sandstone Formation of the Monmouth area (Fig. 6.2, Col. 5) comprises red and variegated coarse-grained sandstone, which passes southwards into limestones of the Hunt's Bay Oolite Subgroup (formerly Drybrook Limestone). Seen as a single sandstone in the northern part of the region, in proximity to the Wales-Brabant High, the Cromhall Sandstone Formation forms three distinct tongues towards the south in the Cromhall type area (Fig. 6.2, Col. 4).

The lower part of the Oxwich Head Limestone Formation in the Mendips area (Fig. 6.2, Col. 2) includes typical Asbian coral-brachiopod assemblages, including *Davidsonina septosa* at the base ^{*5}. The absence of the facies-controlled brachiopod *Daviesiella llangollensis*, typical of the early Asbian, has previously been taken to indicate the presence of a nonsequence at the base of the formation (Kellaway & Welch 1993), but in common with South Wales (Chapter 5), any break is likely to be minor. The Asbian and Brigantian succession in the Monmouth area (Fig. 6.2, Col. 5) is absent beneath the unconformity below the base of the Trenchard Formation.

Namurian

Strata of Namurian age are largely concealed by Triassic rocks and where they do occur at outcrop as the Quartzitic Sandstone Formation in the Somerset, Nailsea, Bristol and Severn coalfields (Fig. 6.2, Cols. 6, 7, 8 & 9) they are typically poorly exposed. The presence of *Tumulites (Eumorphoceras)* sp., brachiopods and molluscs consistent with a Pendleian age (Kellaway & Welch 1955) have been recorded in what is here interpreted as the Aberkenfig Formation ⁺¹ in the eastern side of Broadfield Down (Fig. 6.2, Col. 6). The age of the lower boundary of the overlying

Quartzitic Sandstone Formation is poorly constrained, in contrast with the top of the formation which is conformably overlain by the Subcrenatum Marine Band. In the Ashton Park Borehole (Fig. 6.2, Col. 8) a *Lingula* band marks a macrofloral boundary between typical late Mississippian and early Pennsylvanian species (Kellaway & Welch 1993). Within the Severn Coal Basin (Fig. 6.2, Col. 9), miospores have been recovered from the Portskewett Borehole No. 106 suggesting a Yeadonian age ¹ (Owens in Kellaway & Welch 1993). Strata of Namurian age are absent in the Forest of Dean (Fig. 6.2, Col. 10) and Newent (Col. 11) coalfields.

Westphalian

During the Langsettian to early Bolsovian, the grey, mudstone-dominated fluviolacustrine deposits of the South Wales Coal Measures Group were deposited across the Bristol and Somerset coalfields. The Bristol Coalfield (Fig. 6.2, Col. 3), located to the north and east of Bristol crops out in the Kingswood Anticline and Coalpit Heath Syncline. To the south, the Somerset Coalfield (Fig. 6.2, Col. 1) crops out in the Radstock and Pensford synclines. Exposure of the group is poor and much of the information has been determined from boreholes.

The Subcrenatum (Ashton Vale) Marine Band, which marks the base of the South Wales Lower Coal Measures Formation, is proved in the southern part of the Radstock Syncline (Fig. 6.2, Col. 6 ⁺²; Fig. 6.3: Somerset Coalfield). The marine band is up to about 7 m thick and contains a diverse marine fauna at Ashton Vale (Fig. 6.2, Col. 8 ⁺²; Fig. 6.3: Bristol Coalfield), thinning and containing a more impoverished fauna toward the east and north of Bristol (Green 1992).

The lowest c. 75 m of the South Wales Lower Coal Measures Formation in the Ashton Park Borehole [ST 5633 7146] include up to 4 unnamed *Lingula* bands in a mudstone-dominated succession, with clay ironstones and clay seatearths Fig. 6.2, Col. 8). This succession is attributed to the non-marine bivalve *Lenisulcata* Chronozone ⁻³ by Calver (in Kellaway & Welch 1993). The upper of these *Lingula* Bands develops a more diverse marine assemblage toward the south (e.g. Winford No. 1 Borehole [ST 5573 6375]) and has been equated with the Meadow Farm Marine Band (Ramsbottom *et al.* 1978). The full thickness of the South Wales Lower Coal Measures Formation is proved in the Harry Stoke Borehole A [ST 6226 7905]. In the Somerset Coalfield (Fig. 6.3) the lowermost 135 m below the Perrink Coal has only two relatively thin coals. Above the Perrink Coal measures include non-marine bivalves of the *pseudorobusta* fauna of the *Communis* Chronozone ⁻³ (Green & Welch 1965).

The Vanderbeckei (Harry Stoke) Marine Band is present in the northern part of the Bristol Coalfield (Fig. 6.3) and contains *Lingula mytilloides* (Kellaway & Welch 1993). This marine band is not proved in the Somerset Coalfield (Fig. 6.3), precluding subdivision of the South Wales Coal Measures Group. The Nailsea Syncline (Fig. 6.3), located to the west of and laterally contiguous with the Somerset Coalfield, includes a 270 m-thick succession of mudstones, subordinate sandstones and 12 coal seams attributed to the South Wales Lower and Middle Coal Measures formations (Green 1992). In the Severn Coalfield (Fig. 6.3) these strata, proved in the Cattybrook inlier, are believed to represent a thrust slice from the Bristol Coalfield to the east (Cleal & Thomas 1996).

The Aegiranum (Crofts End) Marine Band comprises a diverse marine faunal assemblage and maintains a thickness of 3.0 to 5.6 m across the Bristol Coalfield (Fig. 6.2, Col. 8⁺⁴; Fig. 6.3; Kellaway & Welch 1993). Above this, coal seams of the upper part of the South Wales Middle Coal Measures Formation are of poor quality.

The Cambriense (Winterbourne) Marine Band is between 1 and 2 m thick in the Harry Stoke boreholes C [ST 6504 7677] and B [ST 6321 7816] and contains brachiopods, bivalves and crinoid columnals (Bristol Coalfield: Fig. 6.3; Kellaway & Welch 1993). In the Bristol Coalfield (Fig. 6.2, Col. 8), the succession between the Cambriense Marine Band and the base of the Pennant Sandstone Formation, formerly the lower part of the Downend Formation (Kellaway & Welch 1993), is now named the Winterbourne Formation (Waters *et al.* 2009). Comprising grey and red mudstone with common thin and lenticular beds of quartz-conglomerate and pebbly sandstone, the formation is equivalent to the Deri Formation of the East Crop of South Wales (see Chapter 5) and represents the local base of the Warwickshire Group. The presence of non-marine bivalves of the *Phillipsii* Chronozone indicates a late Bolsovian age^{~5} (Kellaway & Welch 1993).

During the Bolsovian to Asturian (Westphalian D) a succession dominated by multi-storey fluvial channel sandstones, the Pennant Sandstone Formation, was deposited across all the coalfields, except the Newent Coalfield. Regionally, the base of the formation is diachronous (Fig. 6.3), occurring in the early Bolsovian succession below the Cambriense Marine Band in the Somerset Coalfield (Green & Welch 1965), but above the same marine band in the Bristol Coalfield (Kellaway & Welch 1993). A poor record of *Alethopteris serlii* Subzone macroflora is listed by Cleal (1997) from the Mangotsfield Member (Pennant Sandstone Formation) of the Bristol Coalfield (Fig. 6.2, Col. 8), indicating a late Bolsovian age for the formation^{^6}. The Severn Coalfield (Fig. 6.2, Col. 9) is almost entirely concealed beneath Mesozoic strata, but near to the base of the Pennant Sandstone Formation, non-marine bivalves indicate the *Phillipsii* Chronozone^{~2}, also of late Bolsovian age. The roof measures of the Coleford High Delf Coal at the base of the Pennant Sandstone Formation in the Forest of Dean Coalfield (Fig. 6.2, Col. 10) have yielded macroflora of the *Dicksonites plueckenetii* Subzone^{^2}, indicating a late Asturian age (Cleal 1991). Cleal (1997) identified a Forest of Dean Pennant Formation distinct from the older Pennant Sandstone Formation of South Wales (see Chapter 5), though the two are lithologically and petrographically identical (Stead 1975).

The Trenchard Formation of the Forest of Dean Coalfield (Fig. 6.2, Col. 10) as defined by Waters *et al.* (2009) comprises grey or pinkish grey quartzose sandstones and conglomerates in the northern part of the coalfield, showing palaeocurrents orientated towards the South to WSW (Jones 1972; Stead 1975). Interpreted variously as fluvial (Jones 1972) or littoral marine (Stead 1975), the formation contains miospores of the OD (formerly XI) Biozone (Wagner & Spinner 1972) from the Trenchard Coal^{^1}, suggesting an Asturian age. The formation passes southward into a sandstone-dominated lithic-arenite succession, with palaeocurrents towards the north-west (Jones 1972; Stead 1975). This was formerly referred to as the Trenchard Group by these authors, but considered by Waters *et al.* (2009) to represent part of the Pennant Sandstone Formation. The age of the Stallion Hill Sandstone Formation of

the Newent Coalfield (Fig. 6.2, Col. 11) is not proved, but correlation with the Trenchard Formation has been suggested (Worssam *et al.* 1989).

The exact position of the base of the Asturian is uncertain in the Bristol and Somerset coalfields. Cleal (1997) postulated the presence of a non-sequence between the Pennant Sandstone Formation and the overlying mudstone-dominated Grovesend Formation, on the basis of the absence of records of macroflora of the *Linopteris bunburii* Zone and *L. micromiltoni* Subzone (early Asturian). The Farrington and Radstock members of the Grovesend Formation (Fig. 6.2, Col. 6) contain macroflora typical of the *D. plueckenetii* Subzone, indicating a late Asturian age ^{^5} (Cleal 1997). In the Severn Coalfield (Fig. 6.2, Col. 9) the base of the Grovesend Formation is taken at the base of the lowermost coal seam (the Avonmouth No. 2 Seam) in the thick mainly argillaceous succession (Waters *et al.* 2009). A *D. plueckenetii* Subzone macrofloral assemblage is recorded in this formation in the Severn Coalfield ^{^3} (Cleal 1986b). The mudstone-dominated succession overlying the Stallion Hill Sandstone Formation of the Newent Coalfield (Fig. 6.2, Col. 6) is inferred by Worssam *et al.* (1989) to equate with beds that are now referred to the Grovesend Formation (Waters *et al.*, 2009). Macroflora from this upper succession indicate that most, if not all, of the sequence is no lower than the *Lobopteris vestita* Biozone (late Asturian age) ^{^1} (Cleal 1987). In the Forest of Dean (Fig. 6.2, Col. 10), the Household Coals forming the basal part of the Suprapennant Formation of Cleal (1997) include a *D. plueckenetii* Subzone macrofloral assemblage ^{^3}.

Stephanian

The Publow Member of the Somerset Coalfield (Fig. 6.3; Kellaway & Welch 1993) is the youngest member of the Grovesend Formation. It contains macroflora indicative of the *Odontopteris cantabrica* Zone, of Stephanian age ^{^6} (R H Wagner in Cleal 1997). Macroflora from this zone have also been described from the upper part of the Household Coals (Wagner & Spinner 1972; Cleal 1997) in the Forest of Dean Coalfield ^{^4} (Fig. 6.2, Col. 10), in strata referred to the Suprapennant Formation (Cleal 1997) or Grovesend Formation (Waters *et al.* 2009).

Figures

Fig. 6.1. Geological map showing the distribution of Carboniferous strata of Bristol, Mendips and Forest of Dean, adapted from IGS (1979).

Fig. 6.2. Correlation of Carboniferous successions in Bristol, Mendips and Forest of Dean. The nomenclature is that of Waters *et al.* (2007; 2009), with details from the following publications: Col. 1 from Mitchell *et al.* (1982); Col. 2 from Green & Welch (1965); Col. 3 from Whittaker & Green (1983); Col. 4 from Kellaway & Welch (1993); Col. 5 from Welch & Trotter (1961); Col. 6 from Kellaway & Welch (1993); Col. 7 from Kellaway & Welch (1993); Col. 8 from Kellaway & Welch (1993); Col. 9 from Kellaway & Welch (1993); Col. 10 from Welch & Trotter (1961); Col. 11 from Worssam *et al.* (1989).

Fig. 6.3. Correlation of Westphalian successions in the Somerset, Bristol, Severn and Nailsea coalfields. The nomenclature is that of Waters *et al.* (2007; 2009), with details modified from Kellaway & Welch (1993).

