Chapter 2 The Wessex Basin (Dorset and central Somerset)

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Introduction

The Wessex Basin has seen more intensive research than any other single Lower Jurassic depocentre in Britain. This is largely on account of the exceptional exposure along the Dorset coast of virtually the entire Jurassic succession, but it perhaps also owes something to the fact that the exhumed periclines of the Mendip Hills, at the north-western edge of the basin, allow direct observation of the Palaeozoic basement structures that are believed to have controlled subsidence and uplift throughout the basin's history. Numerous papers have been published on various aspects of the basin, or parts of it (e.g. Stoneley, 1982; Chadwick *et al.,* 1983; Whittaker, 1985; Chadwick, 1986; Lake and Karner, 1987; Jenkyns and Senior, 1991; Evans and Chadwick, 1994, to name but a few). There is also a substantial body of sub-surface data obtained from a large number of boreholes that have been drilled in the search for hydrocarbons (e.g. Sellwood *et al.,* 1986; Ainsworth *et al.,* 1998b) and from geophysical surveys that have been conducted across the area.

The Wessex Basin comprises a series of linked, but nonetheless distinct, roughly E–W-trending, fault-bounded basins separated by relative highs (Chadwick, 1986; 1993; Lake and Karner, 1987; Ainsworth *et al.,* 1998b) (Figure 2.1). In all it covers more than 20 000 km^2 onshore, encompassing the Dorset and Central Somerset basins in the west, and the Pewsey, Weald and part of the Portland–Wight basins farther to the east. At least a comparable area to the south lies beneath the English Channel (Chadwick, 1986), with a further northwestward offshore extension represented by the Bristol Channel Basin (Lloyd *et al.,* 1973; Evans and Thompson, 1979; Tappin *et al.,* 1994). The northern margin of the basin lies roughly along the Variscan Front, defined by the southern flanks of the Welsh Massif and the Mendip High in the west and the London Platform to the east. To the west Palaeozoic basement crops out in Devon, and to the east beneath Kent Lower Jurassic strata onlap the basement of the London–Brabant High (Donovan *et al.,* 1979).

Within the basin the sedimentary fill, of Permian to Tertiary age, lies unconformably upon Lower Palaeozoic to Carboniferous rocks. Typically the fill is about 2 km thick though locally it may exceed 3 km.

The only areas of the Wessex Basin that expose Lower Jurassic strata are in the southwest, extending from the Dorset coast northwards through Somerset to the Bristol Channel. Only the Dorset and Bristol Channel coasts expose extensive sections through the Lower Jurassic Series and elsewhere in the basin exposure is poor. Documentation of small and temporary inland exposures has been made by, among others, Lang (1932), Kellaway and Wilson (1941a), Hallam (1956), Wilson *et al.* (1958), Green and Welch (1965), Hollingworth *et al.* (1990) and Prudden (pers. comm.); much of this information is summarized in Cope *et al.* (1980a).

Lithostratigraphy and facies

Details of facies and lithostratigraphy in Dorset largely are covered in the site account for the Dorset coast, and are also summarized in Ainsworth *et al.* (1998b). In general the succession in the Dorset Basin is attenuated by comparison with that farther north, in the Central Somerset Basin. The exceptional exposure along the Dorset coast has allowed detailed lithostratigraphical subdivision of the succession. Many of the named units are well established with a long history of use. Recent rationalization of the Lower Jurassic lithostratigraphy for England and Wales (Cox *et al.,* 1999) has largely retained these original names. Within this revised lithostratigraphical framework five formations are recognized on the Dorset coast (Figure 2.2) and can, for the most part, be mapped at outcrop inland. Ten members were formally named for the Dorset coast succession, with an eleventh, the Stonebarrow Pyritic Member, proposed for the upper part of the Upper Sinemurian Substage (KN. Page, pers. comm.). Other finer subdivisions have yet to be accorded formal status. The lithostratigraphical framework recognized farther north, and summarized in (Figure 2.3) mostly lacks the high resolution of that on the Dorset coast, reflecting generally poorer exposure and less extensive documentation.

The Blue Lias Formation encompasses the highest part of the Triassic Rhaetian Stage, the Hettangian Stage and the lowest part of the Sinemurian Stage. Throughout the Wessex Basin it is developed in typical facies of alternating limestones and mudstones, superbly exposed at the Pinhay Bay to Fault Corner and Blue Anchor–Lilstock Coast GCR sites in the Dorset and Central Somerset basins respectively. At the basin margins it passes laterally into a more massive limestone, as seen at the Hobbs Quarry and Viaduct Quarry GCR sites on the Mendip High and the Pant y Slade to Witches Point GCR site in south Wales (Chapter 3). The succeeding Charmouth Mudstone Formation, which encompasses much of the Sinemurian Stage and the lower part of the Pliensbachian Stage, is divided into five members (Figure 2.2). These members have been mapped out only close to the coastal exposures, but they have been identified inland in Dorset (e.g. Lang, 1932). On the Dorset coast the Shales-with-Beef Member consists of finely laminated and bituminous dark-grey mudstones with a few bands of limestone nodules or septaria and thin beds of fibrous calcite, or 'beef', which give the member its name. The succeeding Black Ven Marl Member is very similar lithologically, although 'beef' lenses are less well-developed.

The boundary between the two is essentially arbitrary but was drawn below a conspicuous limestone band, the Birchi Tabular (Bed 76a of Lang *et al.,* 1923). In the Central Somerset Basin correlative strata are developed in similar facies to that seen on the Dorset coast, although there is little development of 'beef'. Separate members can be recognized only where distinctive marker beds are present, such as at Chard Junction where the Stellare Nodules near the top of the Black Ven Marl Member have been identified (M.J. Simms, unpublished observations). The succeeding Stonebarrow Pyritic Member, proposed by Page (pers. comm.) for the upper part of the Sinemurian Stage, comprises blue-grey shaly to blocky mudstones with often abundant pyritic ammonites. On the Dorset coast it is represented by some 14 m of sediment in the lower part of the Raricostatum Zone, bounded above and below by significant non-sequences. In the Central Somerset Basin it is more fully developed; at Castle Cary the member is more than 24 m thick and encompasses both the Oxynotum and Raricostatum zones (Hollingworth *et al.,* 1990). Between the Dorset and Central Somerset basins the Stonebarrow Pyritic Member is greatly reduced in thickness. At Chard Junction it comprises only about 2 m of mudstone of the Raricostatum Zone resting non-sequentially on dark mudstones with septaria of the Black Ven Marl Member, and is overlain, also non-sequentially, by pale belemnite-rich mudstones of the Belemnite Marl Member (M J. Simms, unpublished observations).

The Belemnite Marl Member on the Dorset coast comprises rhythmic alternations of light and dark calcareous or pyritic mudstones often rich in belemnites. The succeeding Green Ammonite Mudstone Member consists of blue-grey mudstones with a few thin beds of nodules. They are seldom identified as separate members at outcrop in the Central Somerset Basin, although belemnite-rich mudstones are present in the lower part. The Dyrham Formation is divided into three members on the Dorset coast but these cannot be recognized inland. The formation is significantly thinner in the Central Somerset Basin than in Dorset, though this can be ascribed largely to the anomalous thickness of the Eype Clay Member. The Beacon Limestone Formation comprises two units; the Marlstone Rock Member below and the Eype Mouth Limestone Member (in the Dorset Basin) and Barrington Limestone Member (in the Central Somerset Basin) above. The formation is highly condensed and shows marked lateral thickness changes associated with syn-sedimentary faults (Jenkyns and Senior, 1991). It spans the highest part of the Pliensbachian Stage and most of the Toarcian Stage. On the Dorset coast it is succeeded by several tens of metres of siltstones and sandstones of the Bridport Sand Formation, which encompasses the highest part of the Toarcian Stage and the lowest part of the Aalenian Stage. There are local developments of bioclastic limestone within the Bridport Sand Formation of the Central Somerset Basin, notably at the Ham Hill GCR site. The lithostratigraphical subdivisions of the Lias Group for the Dorset coast are summarized in (Figure 2.2). The lithostratigraphy of GCR sites farther north in the Wessex Basin, and on the Mendip High and South Wales Massif; is summarized in (Figure 2.3).

Basin development

The 'Wessex Basin' is an inclusive term for a series of inter-connected E–W-orientated asymmetric grabens or half-grabens bounded by major faults or fault zones downthrowing mainly to the south (Figure 2.1). Geophysical investigations show that these normal faults developed in association with extensional re-activation of concealed Variscan thrust faults in the basement rocks (Chadwick *et al.,* 1983; Chadwick, 1986, 1993). The syn-depositional nature of this extensional faulting is shown by significantly thicker sequences on the downthrown side of many of the faults (e.g.

Chadwick, 1986; Jenkyns and Senior, 1991; Hesselbo and Jenkyns, 1995). The structure of part of the underlying basement can be examined at outcrop in the Mendip Hills, where direct evidence of Mesozoic fault activity is well documented (Jenkyns and Senior, 1991; Simms, 1997), and on the south Wales coast (Chapter 3). Concealed basement highs analogous to the Mendip High have been identified at depth on the south side of some of the major extensional faults that cross the Wessex Basin (Holloway and Chadwick, 1984; Evans and Chadwick, 1994). The Wessex Basin experienced tectonic inversion as a result of compression during Tertiary times (Lake and Karner, 1987; Chadwick, 1993), the latest episode in a long history of subsidence and inversion.

The Central Somerset Basin lies towards the north-western corner of the larger Wessex Basin and is bounded to the north by the Palaeozoic outcrop of the Mendip High. Geophysical evidence shows that its structure at depth is essentially the same as that now exposed on the Mendip High (Chadwick *et al.,* 1983; Chadwick, 1986, 1993). To the east it is continuous with the Pewsey Basin whereas to the north-west it passes into the Bristol Channel Basin. Van Hoorn (1987a) and Brooks *et al.* (1988) interpreted the latter as a Mesozoic half-graben formed above a southward-dipping normal fault developed on a re-activated Variscan thrust. The boundary between the Central Somerset and Bristol Channel basins is perhaps best defined by a major strike-slip structure,' the Watchet–Cothelstone–Hatch Fault System. The Central Somerset and Dorset basins are separated by the westward extension of the Cranbome-Fordingbridge High (Figure 2.1).

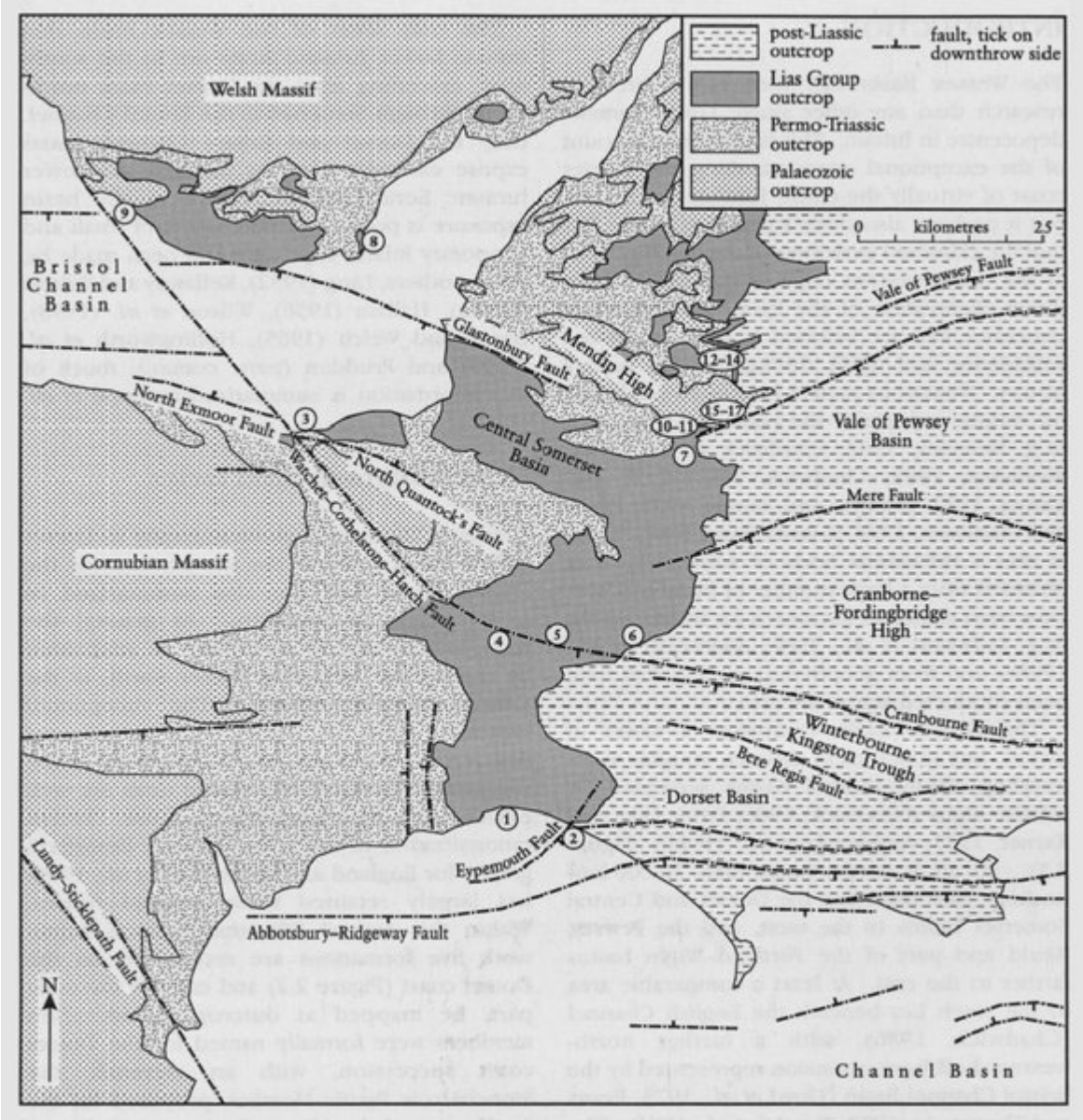
The Dorset, Central Somerset and Bristol Channel basins probably formed during the Permian Period, with the Watchet–Cothelstone–Hatch Fault System acting as a zone of transfer between southern and northern, possibly syn-orogenic, extension. The east–west strike of the basement thrusts is reflected in the east–west orientation of the Bristol Channel Basin and the Mendip and Cranbourne–Fordingbridge highs, while the NW-trending faults, which together comprise the Watchet–Cothelstone–Hatch Fault System, represent lateral ramps to these thrusts.

Comparison with other areas

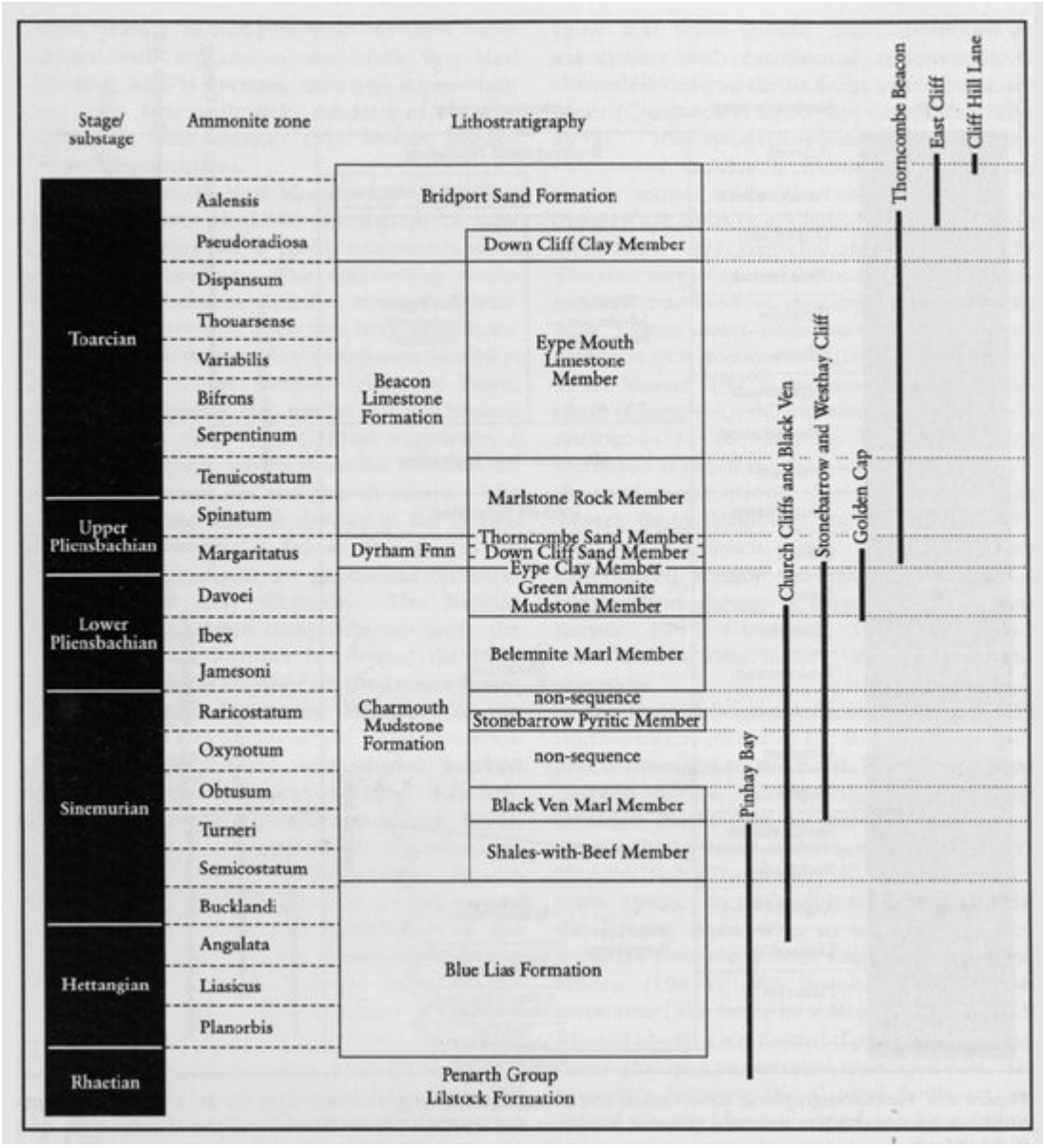
Because of the long history of investigation of the Lower Jurassic succession on the Dorset coast, the sequence there is often taken as the 'standard' against which correlative successions elsewhere are compared. The lithostratigraphy of the Wessex Basin shows greater contrasts with the more distant basins, such as those of Cleveland and the Hebrides, than with those of the nearby Severn Basin and East Midlands Shelf. In a comparison of the Wessex and Cleveland basins, Hesselbo and Jenkyns (1995) concluded that the large-scale facies differences between the two reflected the more proximal (to land) setting of the Cleveland Basin. The same interpretation can probably be applied to the Hebrides Basin. The most obvious significant difference between the Wessex Basin succession and those elsewhere occurs in the Toarcian Stage, where dark laminated mudstones, which are present across most of Britain and mainland Europe, are represented by the highly condensed Beacon Limestone Formation. This difference undoubtedly reflects local structural controls. Structural influences on the Wessex Basin succession are also evident from the reduced thickness of the overall succession and greater frequency of hiatuses on the Dorset coast compared with that in the Central Somerset Basin, or with those in the Severn or Cleveland basins.

The distribution of faunal elements through the Lower Jurassic succession of the Wessex Basin typically reflects either their biostratigraphical range (vertical distribution) or facies control (lateral distribution). Provincialism has been documented among two invertebrate groups in particular. In the Upper Pliensbachian Stage Ager's (1956a) work on brachiopods distinguished a South-western Province (the Wessex and Severn basins) from three others farther north. Within this province he recognized distinct Bridport and Ilminster sub-provinces, which effectively correspond to the Dorset and Central Somerset basins, and a Gloucester Subprovince corresponding to the Severn Basin, that was transitional to the Midland Province farther north. Howarth (1958) noted a close correlation between the brachiopod provinces recognized by Ager (1956a) and the distribution of species of the ammonite genus *Pleuroceras.* Both authors noted a profound difference in faunal composition between the South-western and Yorkshire provinces that they attributed to physical barriers to migration of the various taxa.

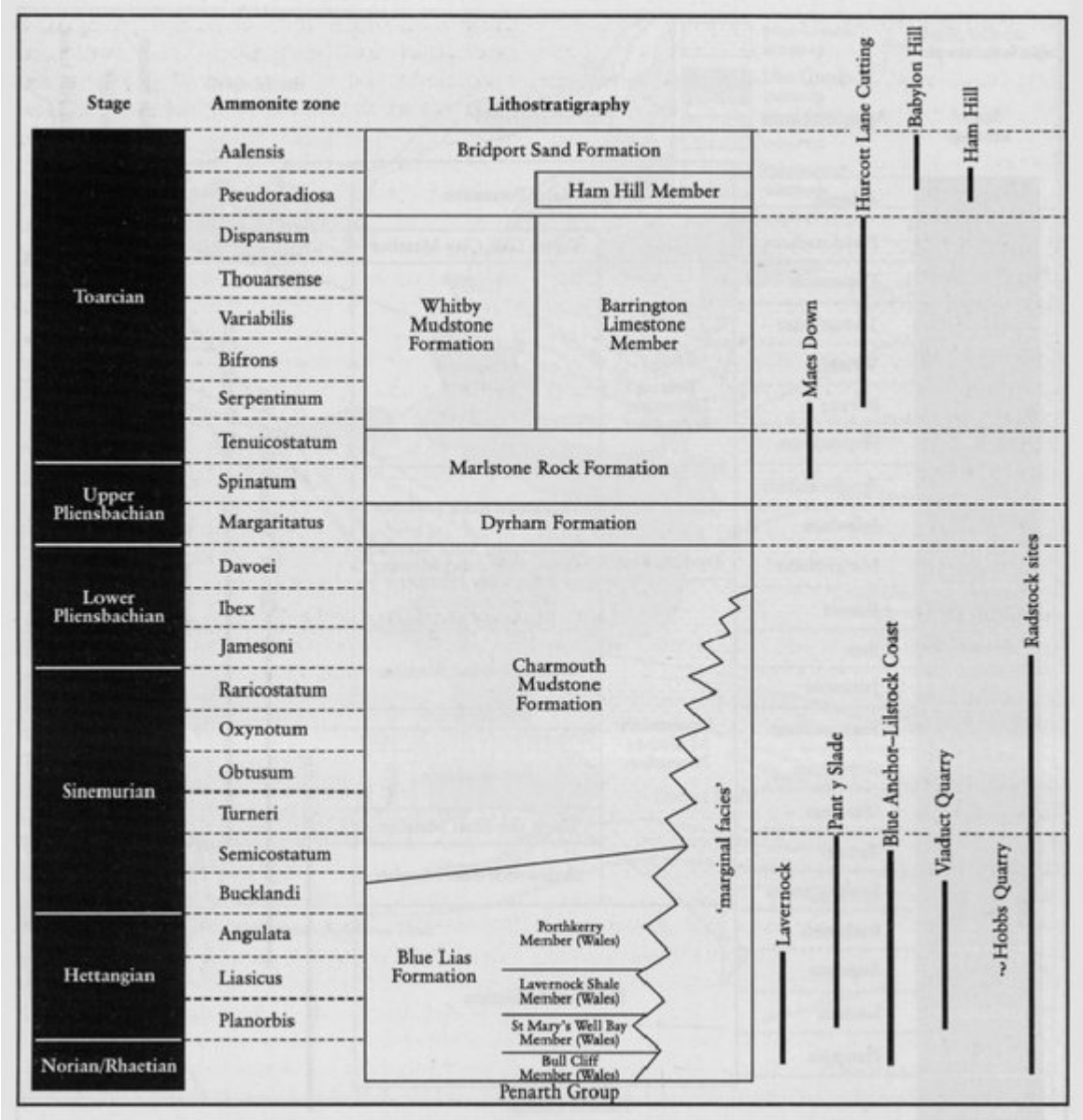
References



(Figure 2.1) The major structural elements and sub-basins of the Wessex Basin and its margins. Numbers correspond to the locations of the GCR sites: 1— Pinhay Bay to Fault Corner and East Cliff; 2 — Cliff Hill Road Section; 3 — Blue Anchor—Lilstock Coast; 4 — Hurcott Lane Cutting; 5 — Babylon Hill; 6 — Ham Hill; 7 — Maes Down; 8 — Lavernock to St Mary's Well Bay; 9 — Pant y Slade to Witches Point; 10 — Viaduct Quarry; 11 — Hobbs Quarry; 12 — Bowldish Quarry; 13 — Kilmersdon Road Quarry; 14 — Huish Colliery Quarry; 15 — Cloford Quarry; 16 — Holwell Quarry; 17 — Leighton Road Cutting. After Lake and Karner (1987).



(Figure 2.2) Lithostratigraphical subdivisions and stratigraphical ranges of GCR sites for the Lias Group of the Dorset coast, in the southern part of the Wessex Basin.



(Figure 2.3) Lithostratigraphical subdivisions and stratigraphical ranges of GCR sites for the Lias Group in the northern part of the Wessex Basin (Central Somerset and Bristol Channel basins) and the Mendip High and Welsh Massif.