Post-Variscan structure and sedimentation, Bristol and Gloucester region

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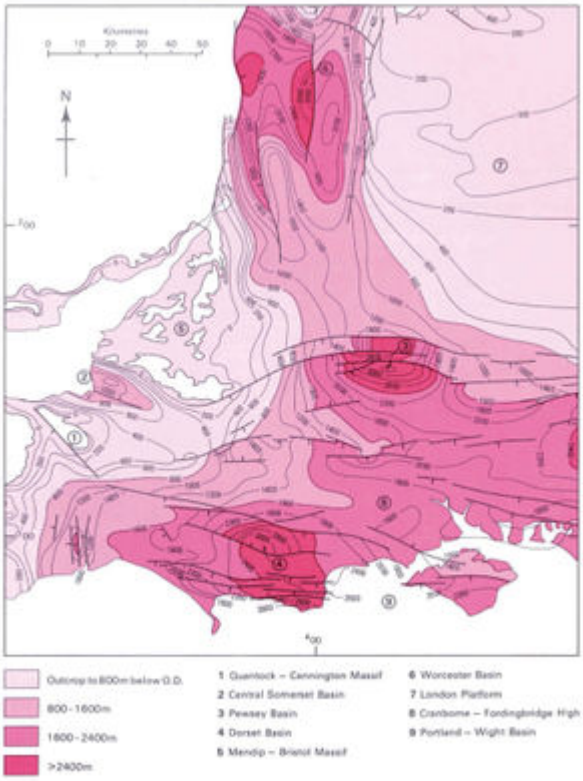
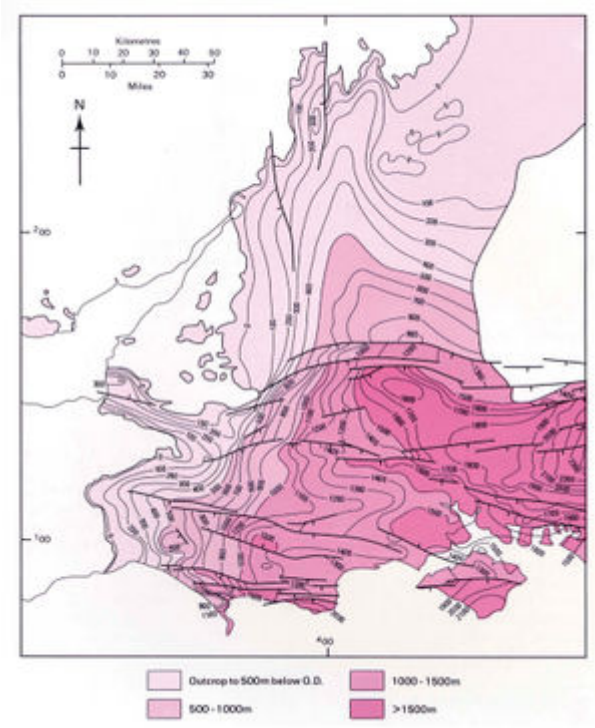
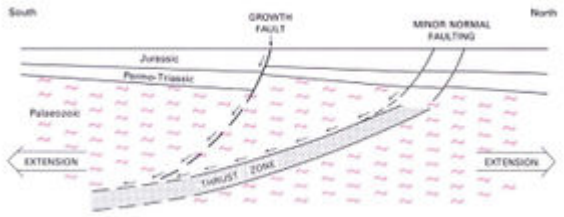
Green, G W. 1992. British regional geology: Bristol and Gloucester region (Third edition). (London: HMSO for the British Geological Survey.)



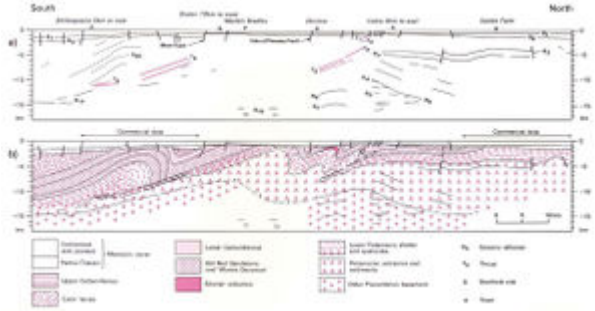
Depth to top of Variscan Basement (after Whittaker, 1985)[1]. (P948987)



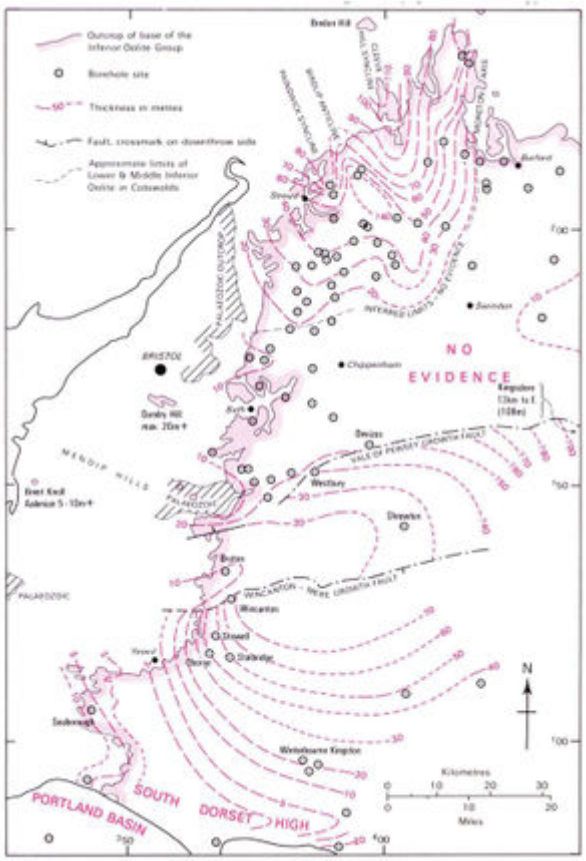
Depth to top of Penarth Group (after Whittaker 1985)[1]. Annotation as for Figure 32. a. Somerton Anticline. (P948988)



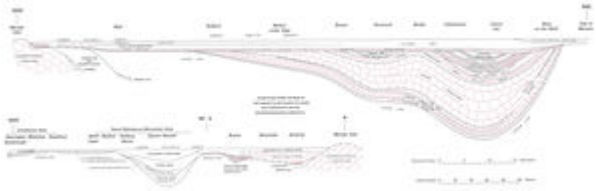
Reactivation and reversal of a Variscan thrust zone to explain Mesozoic growth on the Vale of Pewsey Fault (after Chadwick, Kenolty and Whittaker, 1983, fig. 12)[2]. (P948989)



North–south sections showing a) principal reflectors identified from seismic reflection sections and b) geological interpretation of reflection events (after Chadwick, Kenolty and Whittaker, 1983)[2]. (P948971)g



Isopach map of the Inferior Oolite Group. (P948982)



A Horizontal diagrammatic section through the Inferior Oolite Group of the Cotswolds. B Horizontal diagrammatic section through the Inferior Oolite Group of the Mendip-Crewkerne region. (P948991)

Since the last edition (1948) of this handbook the analysis of Mesozoic sedimentation in England and Wales has greatly advanced under the stimulus of the search for oil and the revolution in geology following the introduction of the theory of plate tectonics. In the classic paper by Godwin-Austin in 1856 and continuing up to Arkell (1933)[3], Mesozoic sedimentation, particularly in the Jurassic, was explained in terms of both major and minor ridges or axes of relative uplift, along which the sedimentation was slow and often interrupted, and intervening troughs of thicker, more continuous sedimentation. These features were said to be controlled by posthumous movement of pre-existing basement structures; for example, axes of uplift were considered to be underlain by anticlinal structures in the basement. In the 1948 edition, the controlling basement structures were described as ‘lines of structural weakness’ and it was said that ‘the seemingly haphazard variations of lithology (are) seen to be intimately related to continuous instability along the axial lines’. The number of axes was augmented, in particular by the addition of the major Bath Axis, which was seen as a southerly manifestation of the old established ‘Malvern Line’.

Kent (1949)[4] published a structure contour map of the pre-Permian surface of the whole of England and Wales and delineated the major structural units of the Mesozoic cover, showing them to be on

‘essentially different lines from those which controlled pre-Permian sedimentation’. He showed that the axes of uplift were relatively localised features within a framework of large-scale Mesozoic epeirogenic movements controlling sedimentation.

Drilling and geophysical studies, particularly in connection with hydrocarbon exploration, have latterly greatly increased our knowledge and understanding of the structure of England and Wales both offshore and onshore. The data have been incorporated in a series of structure contour and isopach maps recently published for the British Geological Survey (Whittaker, 1985)[1]. The results, when combined with modern theories of crustal and lithospheric extension, have provided models for extension-related basin development that are well illustrated in the present region by the Worcester and Wessex basins (Chadwick 1985[5], 1986[6]). Extension was most obviously achieved by major growth faults, that is faults which were actively moving during sedimentation and which thereby directly affected the pattern of deposition. The locations of such faults appear to have been determined by pre-existing lines of weakness in the basement. Movement on the major basin-controlling growth faults was accompanied by widespread, but smaller-scale, syn-depositional normal faulting. Detailed analysis of seismic sections shows major faulting episodes in Permian-early Triassic, early Liassic and late Jurassic–early Cretaceous times.

Main structural elements

The main structures of the region are part of major structural units that extend beyond its confines. They constitute massifs, or ‘positive’ areas, over which Mesozoic sedimentation was much reduced and often interrupted, and ‘negative’, down warped basinal areas, in which a considerable thickness of sediment accumulated with little or no interruption.

P948987 shows the depth to the top of the pre-Permian Variscan basement and P948988 the depth to the top of the Penarth Group. Although some allowance must be made for the initial irregularity of the pre-Permian landscape, comparison of the two maps shows that the main post-Variscan structures were already established before the deposition of the Penarth Group and that subsequent movement resulted in their further development. The broad correspondence of the trend of the Palaeozoic basement structures with that of the Mesozoic structures is also seen.

Owing to considerable erosion of the Mesozoic cover, the contribution of post-Bathonian movement to the various structural elements can only be inferred by reference to immediately adjacent areas and is considered in a concluding section.

Quantock–Cannington Massif

Only the eastern part of the massif is included within the region. It is a Variscan anticlinal structure which formed a positive area in early Mesozoic times; it corresponds approximately to Arkell’s North Devon Axis. The Permo-Triassic formations attenuate and/or overlap against it, from all directions. The Lower Lias of west Somerset thins towards the Quantock Hills, although no Jurassic strata now survive in contact with the basement. The south-western side of the Quantocks is formed by the major Cothelstone Fault, a Variscan structure with an estimated dextral horizontal displacement of about 5 km and a vertical downthrow to the south-west of about 2 km. During Permian and early Triassic times it behaved as a growth fault; there is evidence of renewed, smaller post-Lower Liassic movement along it in the Watchet area. The fault continues eastwards across the Wessex Basin as the Cranborne Fault. The nature of the north-eastern boundary of the massif at depth is unknown because of the overlap of the Mercia Mudstone Group onto the Palaeozoic basement, but there may be faulting at depth.

Wessex Basin

The Wessex Basin comprises a series of generally east-west-trending, en échelon, fault-controlled sub-basins or half-grabens bounded by growth faults, with intervening ‘highs’ on which subsidence was less marked. The basin overlies the Variscan fold belt, which extends from the Bristol Channel approaches eastwards to Bridgwater Bay, then eastwards across southern England (P948987).

The Central Somerset Basin consists of faulted en échelon downfolds. The Per- mian and the older Triassic strata, proved in Bridgwater Bay, are overlapped towards the margins of the basin by younger Triassic strata, which directly overlie the basement in the marginal areas. To the east, the Pewsey Vale Basin is bounded by the Pewsey Growth Fault and the group of minor faults farther north, which overlie the Variscan Front at depth. Farther south, the Mere Growth Fault separates the Bruton 'high' from a minor basin at Mere to the south, and the Coker-Cranborne faults separate the Cranborne-Fordingbridge 'high' from the Dorset Basin to the south (P948987). The northerly group of faults, including the Pewsey Fault and the Mere Fault, have been attributed to extensional or normal reactivation of underlying Variscan thrusts identified in the basement by seismic methods (P948989). The main depositional centres of the Wessex Basin lie in Dorset and the Weald to the east of the present region.

Mendip-Bristol Massif

This is the positive area lying to the north of the Central Somerset Basin and south-west of the Worcester Basin. Sediments younger than the Lower Jurassic are now largely absent from it due to subsequent erosion.

The southern margin of the massif is formed by the Mendips. The Mendip ‘Axis’, long figured as one of the major Jurassic axes of uplift, was one of the few that could be directly related to anticlinal structures in the underlying basement. Kent (1949)[7], commenting on the pre-Permian structure contour map, pointed out that ‘the Mendip area appears as a shelf-like projection from the Welsh Highlands and the thin development of Jurassic rocks (on the Radstock Shelf) may be regarded as a shoreline condition — an extension of the littoral region of Glamorgan’. The base of the Lower Lias within the massif shows gentle folds with an amplitude of up to 100 m, though an amplitude of 200 m or more is evident in the axial periclinal fold along the Mendips. Although inclination of the beds is partly due to a combination of nearshore depositional slopes and stratal attenuation (i.e. Kent’s ‘Shoreline condition’), it cannot all be so explained; it is also due to post-Triassic warping and faulting which was greatest over the Mendips themselves.

Worcester (or Severn) Basin

Recent geophysical and drilling information has now defined the form of this north-south-trending basin, in which great thicknesses of Permo-Triassic sediments accumulated in two main depositional areas defined by important growth faults (P948987). The faults on the western side of the basin form part of the Malvern Fault Belt, which was upthrust in Variscan times, after which the movement was reversed in the Permian and Triassic periods. Contrary to many previously stated opinions, the greater part of the basin is now known to be mainly underlain by Precambrian-Tremadocian basement; it thus provides a spectacular example of inversion tectonics (Chadwick and Smith, 1988)[8].

From the south of the Malverns to the south bank of the Severn at Tites Point, the basin-edge is marked by north–south-trending en échelon faults which strongly downthrow the Lower Lias and Mercia Mudstone Group strata to the east against Precambrian and Palaeozoic basement. The geophysical evidence indicates that a steep Triassic–Precambrian/Palaeozoic contact continues

beneath the Lower Lias at least as far as the east-west-trending (Variscan) Kingswood Anticline. Attempts by various authors to project the Malvern Line farther south towards the Dorset Coast, mainly on the basis of trends and facies differences in the Mesozoic cover, must be viewed cautiously, not only because of the intense structural over-printing of the basement by the Variscan orogeny but also because of the restricted understanding of east-west facies variation in the cover itself. The eastern limit of the Severn Basin is taken at the Moreton 'Axis', which may also be taken to define the western edge of the London Platform. The basin merges southwards into the Wessex Basin, the dividing line being taken at the change in trend from north–south to a predominantly east-west direction which corresponds at depth to where the Variscan Front thrusts have been identified (cp. P948971 and P948987).

The Worcester Basin continued to subside throughout Lower Jurassic times, though the depositional centre apparently moved southwards (P948987, P948988). During deposition of the Inferior Oolite, the southern limit of the basin temporarily retreated northwards (P948982).

London Platform

This Mesozoic positive area, which is founded upon relatively weakly deformed Variscan Foreland basement rocks, extends eastwards across Central England and East Anglia into Europe as the London–Brabant Massif. Only its extreme western limit is present in the region, where it terminates at the Vale of Moreton 'Axis'. The latter is a very gently southwards-plunging, north-south-trending asymmetrical anticline. West to east overlap, overstep and attenuation of the strata onto the London Platform occurred in the vicinity of the Vale of Moreton through Triassic into Bathonian times (P948991). The earlier literature, rather uncritically, related these features to the present day anticline, but it was later appreciated that they extended eastwards over a much wider area, known as the 'Oxfordshire Shallows'. Borehole evidence has since shown the features to reflect transgressions and regressions from the subsiding Severn Basin in the west across the margin of the London Platform in the east. Structurally, the net effect of the long-continued differential subsidence has been to produce a monoclinal downwarp of considerable amplitude, facing west towards the Worcester Basin in the older Mesozoic rocks (P948988). The initiation of this downwarping is generally agreed to be of Permo-Triassic age. The presence of basinward graben-faulting is indicated by the great differences of thickness of Permo-Triassic sediments between the basin and platform; this has been confirmed by geophysical data.

Post-Bathonian structural history

The post-Bathonian structural history of the district remains elusive. Numerous faults, usually normal and with throws of less than 50 m, affect the Mesozoic rocks throughout the district. Most predate the Chalk, but a smaller number postdate it. Recent seismic evidence shows that syndepositional faults may be much more common than had previously been suspected.

At least two important phases of earth movement can be assumed to have affected the structure. First, an important period of erosion took place in earliest Cretaceous times (the 'Late Cimmerian' Unconformity), following regional uplift and preceding the widespread transgression marked by the Lower Greensand and the Gault. Thus, whereas Lower Cretaceous rocks rest on strata as high as probable Portlandian in the East Bristol Channel Basin, they overlie the Oxford Clay on the eastern margin of the region, near Westbury. It may therefore be conjectured that the region had become a positive area by latest Jurassic or earliest Cretaceous times.

The second important episode occurred during the Miocene and consisted of north-south compressional movements. The most spectacular effects are present to the south of the region in the

Dorset coastal area, where major tectonic inversion has long been known. Within the region, where the Cretaceous cover remains, the deformation resulted in reversal of the movement along the Mere and Vale of Pewsey growth faults and in associated anticlinal folding. Away from the Cretaceous outcrops the deformation may be presumed to have enhanced, if not formed the present configuration of such east-west-trending structures as the Somerton Anticline (P948988) and the arching of the Mendip Mesozoic cover. Re-activation along the line of the Cothelstone Fault may have occurred during Miocene times, where a post-Liassic reverse fault on the coast at Watchet downthrows 55 m to the north-east and shows a dextral displacement of about 275 m.

References

1. ↑ 1.0 1.1 1.2 Whittaker, A. 1985 (editor). *Atlas of onshore sedimentary basins in England and Wales:* Post-Carboniferous tectonics and stratigraphy. (Blackie: Glasgow and London.)
2. ↑ 2.0 2.1 Chadwick, R A, Kenolty, N, and Whittaker, A. 1983. Crustal structure beneath southern England from deep seismic reflection profiles. *Journal of the Geological Society of London*, Vol. 140, 893–911.
3. ↑ Arkell, W J. 1933. *The Jurassic System in Great Britain*. (Clarendon Press: Oxford.)
4. ↑ Kent, P E. 1949. A structure contour map of the buried Pre-Permian rocks of England and Wales. *Proceedings of the Geologists' Association*, Vol. 60, 87–104.
5. ↑ Chadwick, R A. 1985. Seismic reflection investigations into the stratigraphy and structural evolution of the Worcester Basin. *Journal of the Geological Society of London,* Vol. 142, 187–202.
6. ↑ Chadwick, R A.1986. Extension tectonics in the Wessex Basin, southern England. Journal of the Geological Society of London, Vol. 143, 465–488.
7. ↑ Kent, P E. 1949. A structure contour map of the buried Pre-Permian rocks of England and Wales. *Proceedings of the Geologists' Association*, Vol. 60, 87–104.
8. ↑ Chadwick, R A, and Smith, N J P. 1988. Evidence of negative structural inversion beneath central England from new seismic reflection data. *Journal of the Geological Society of London,* Vol. 145, 519–522.

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