The geological history of the Isle of Wight: an overview of the 'diamond in Britain's geological crown'

Abstract

The geology of the Isle of Wight has attracted both the amateur and professional geologist alike for well over two centuries. It presents a cornucopia of things geological and offers a window into the fascinating story of the geological history and landscape development of southern England, as well as an important teaching resource for all levels of study from primary education through to academic research.

This paper provides a geological framework and a summary of the history of research as context for the papers in this issue can be placed. Inevitably, it can only offer a précis of the huge amount of information available, but it is hoped will also give added impetus to further investigation of the literature or, indeed, new research.

The island offers a field workshop for topics such as lithostratigraphy, sequence stratigraphy, tectonics and climate change; studies that are becoming ever more international in their influence. There are 15 Sites of Special Scientific Interest designated because of their geological importance and a number of these are internationally significant.

After a brief discussion on the concealed geology, this paper concentrates on an outline of the near-surface geology on the coast and inland, and introduces a different view on the structure of the Cretaceous and Palaeogene strata. The enigmatic Quaternary deposits are discussed particularly with reference to the development of the Solent River, human occupation and climate change.

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1. Introduction

This Special Issue of the Proceedings of the Geologists' Association (PGA) provides results arising from the British Geological Survey's Isle of Wight Integrated Project. This project, commenced in September 2007 and is due for completion in March of 2012, is funded from a number of programmes within the Survey's National Capability remit to improve the understanding and distribution of the near-surface geology, creating representational models of the 3D structure and providing the essential framework information for use by the geological community operating in this classic area of British geology.

The project outputs are principally aimed at users such as academia, local authorities and statutory bodies, but also at the large number of 'geo-tourists' that are such an important part of the island's economy. The principal outputs will be in the form of a new 1:50 000 scale Geological Map Special Sheet and a Sheet Explanation booklet, each illustrating the surface and sub-surface geology, as well as papers in journals such as those included in this volume of the PGA.

This overview is split into four sections. This introduction provides a brief historical perspective of geological investigations on the island. The second part places the island in the context of the structural development of the southern part of England through geological time. Section three provides an outline of the geological units encountered both in the subcrop and at surface. The fourth section briefly touches on our interaction with the island's rocks. In each section the references quoted are by no means exhaustive but point the reader to the large estate of geological knowledge available for the island.

The articles in this issue range from descriptive texts illuminating the structural development of this part of southern England; aspects of the islands stratigraphy; the engineering geology and hence land-sliding characteristics of some of the formations exposed. It further includes short notes illustrating other topics such as the biostratigraphy of individual units, building stones, the use of geology in archaeological studies and the growing importance of geo-diversity studies. The individual articles add significantly to the understanding of the island's geology, provide additional key references closely tied to the subjects discussed and will engender some further debate. Each of these articles is highlighted at the appropriate place in this overview.

The Isle of Wight (Fig. 1), the largest in England (384 km^2), has long been regarded as one of the most significant of the classic areas of British geology. It has been a 'mecca' for geological studies since the early 1800s. This interest has spawned an industry of competing geo-tourist guides and pamphlets. Many of the earliest are no more than descriptions of leisurely tours, locations to visit, as well as describing selected views and geomorphological features. All of them offer something of a social commentary of their times, for example in Mill (1832), Ware (1871) and the Ward Lock and Co. series - 'Illustrated Guide to the Isle of Wight' - first published in 1880 and almost annually thereafter until the 1970s. Many, however, carry the reader through the spectacularly exposed rocks on the coast and their inland occurrences in great detail. Pre-eminent amongst these are perhaps Englefield (1816) and Mantell (1847, 1851, 1854; editions that also carry one of the earliest published geological maps, see Fig. 2), and in terms of volume of publications, the many-editioned Brannon's Pictures of the Isle of Wight (e.g. 1848) [also see Vectis Scenery by the same author] and numerous other titles that he printed and published from his home in Wootton Common on the island. There are, in addition, many other notable tour guides and geological reviews, for example: Nelson (1859), Wilkins (1859), Venables (1860), Norman (1887), Colenutt (in Morey, 1909), Clinch (1921), Hughes (1922) to name just some of the more readable.

Of course, there were many Victorian geological treatises of perhaps greater worth to the student of geology, such as the Memoirs of the Geological Survey (Forbes, 1856; Bristow, 1862; Reid and Strahan, 1889; and White 1921) and many articles in the then fledgling scientific publications such as the Journal of the Geological Society (e.g. Prestwich, 1846; Fitton, 1847; Webster, 1814 [in the Transactions]), Geological

Magazine (e.g. Jukes-Browne, 1877; Reid, 1887) and the Proceedings of the Geologist's' Association (e.g. Rowe, 1908).

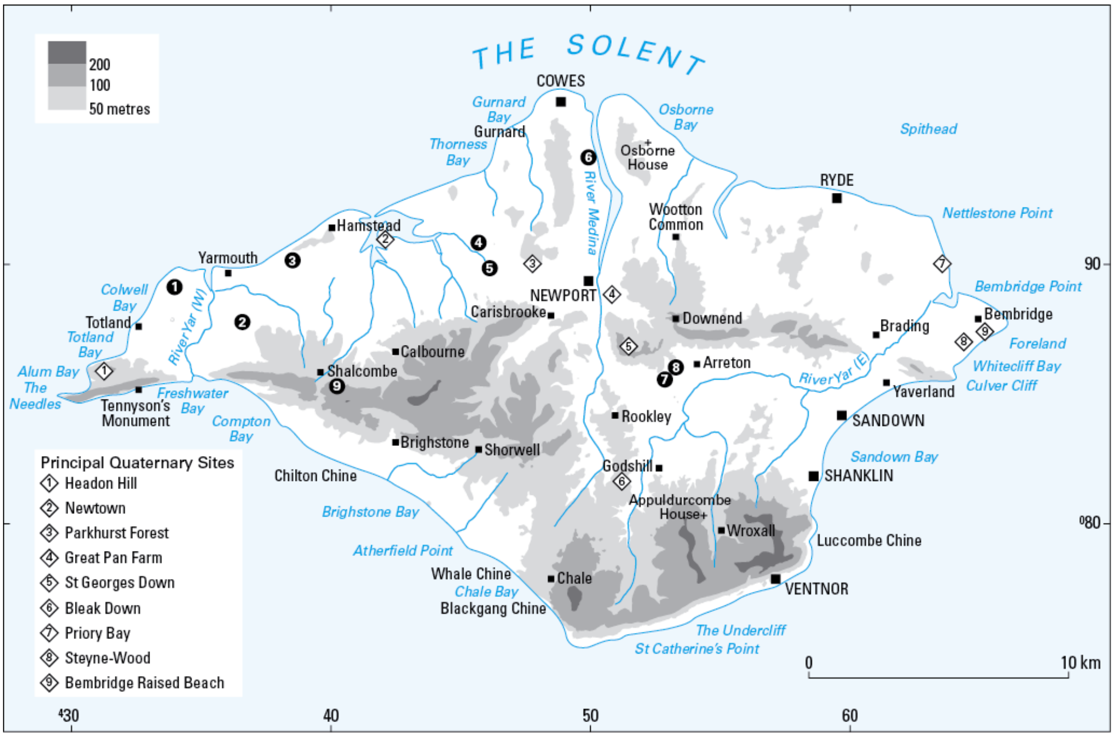


Fig. 1. The outline topography, principal towns and locations of geological interest on the Isle of Wight.
Deep Boreholes: **1**. Norton 1, SZ38NW18 [SZ 34006 89098]; **2**. Wilmingham 1, SZS38NE9 [SZ 36620 87790]; **3**. Bouldnor Copse 1, SZ39SE1 [SZ 38537 90179]; **4**. Sandhills 1, SZ49SE3 [SZ 45700 90850]; **5**. Sandhills 2, SZ48NE55 [SZ 46129 89850]; **6**. Cowes 1 (Bottom Copse), SZ59SW17 [SZ 50036 94161]; **7**. Arreton 1, SZ58NW2 [SZS 53070 85640]; **8**. Arreton 2, SZ58NW1 [SZ 53200 85800]; **9**. Chessell 1, SZ48NW11 [SZ 40571 85581].

The island is, and has been, very popular for geological field excursions to satisfy all levels of academic attainment from primary and secondary school levels through to academic research studies. Indeed this long-term interest is illustrated by the numerous field meetings run by the Geologists' Association. Excursion reports, describing various aspects of the geology in the Isle of Wight, were published at regular intervals within the Proceedings up to the present day (1864 [reported in the Geological and Natural History Reportory for 1866], 1882, 1892, 1896, 1906, 1919, 1933, 1948, 1954, 1957, 1962, 1964, 1971, 1974, 1979, 1994). The Geologists' Association also published a Guide (No.25) on the geology of "The Isle of Wight" (Curry and Wright, 1958) that was subsequently revised (Curry et al., 1966; 1972; Daley and Insole, 1984) before being reissued, later, as Guide No.60 (Insole, Daley and Gale, 1998). The Association also featured the island in its 50th Jubilee Volume (Herries, 1909), wherein a comprehensive review of the complete geological succession was given. In addition, there are a great number field guides written for professional organisations dedicated to various aspects of the islands geology, for example Wach and Ruffell, (1991) and Briant et al. (2009) to name just two; a large number of PhD theses (e.g. Daley, 1969; Swiecicki, 1980; Laurie, 2006 and many more) and, of course, perhaps the largest number of learned papers for any area of the

British Isles of this size. The bibliography within the 5th impression of White's Memoir (1994) is extensive, but by no means comprehensive, given the upsurge in interest in the island's geology within both PhD theses and papers since the 1980s. Many newer references and the revised terminology for the Chalk and the Lower Cretaceous strata on the island, used throughout the issue, are contained in two research reports of the British Geological Survey (Hopson, 2005; Hopson et al., 2008) that can be downloaded free from the BGS website at http://www.bgs.ac.uk/downloads/browse.cfm?sec=1&cat=2 . The rock descriptions used in the articles herein generally conform to those defined in Volume 3 (Sedimentary Rocks) of the Rock Classification Scheme at http://www.bgs.ac.uk/downloads/browse.cfm?sec=1&cat=1 and is also free for download.

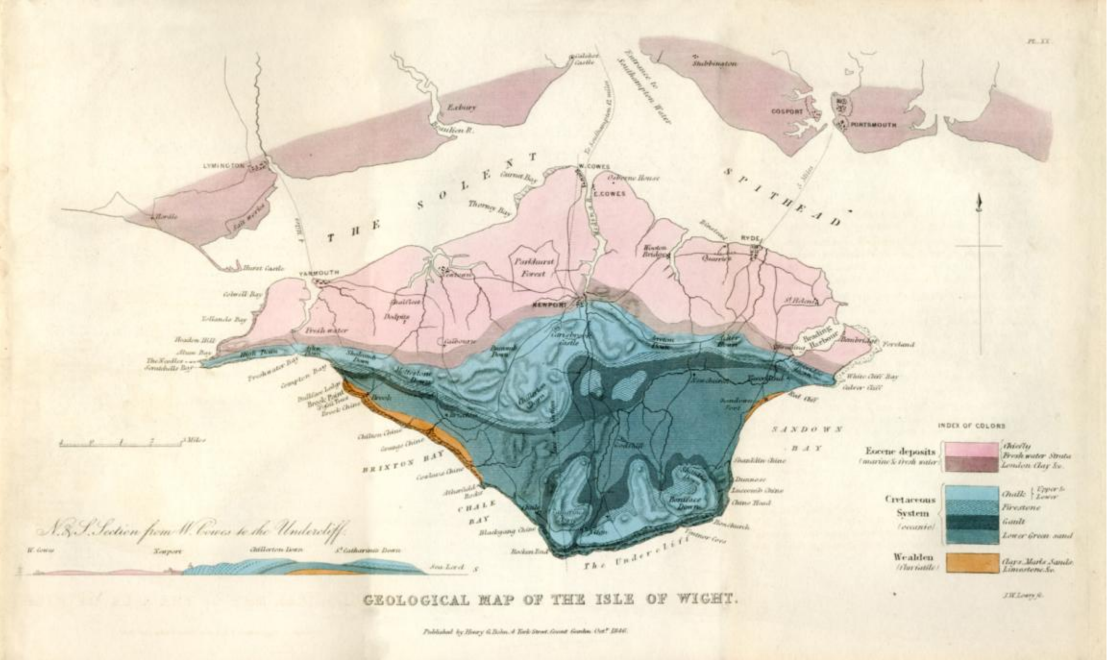


Fig. 2. One of the earliest geological maps of the Isle of Wight taken from Mantell (1847), originally published in 1846 by Henry G Bohn of London.

With the exception of the Jurassic strata (proven at depth in hydrocarbon exploration boreholes) the island is a microcosm of the later Mesozoic and Cenozoic strata that are found widely across south-eastern England. This succession is laid bare in spectacular sea-cliffs, stretching for a total of 98 km, that provide essential viewing for both the amateur and professional geologist. Indeed it is true to say that the cliff sections around the island have been the focus of the greater part of the geological study to the detriment of the description of some equally illuminating inland sections and outcrops. These coastal cliffs provide significant outcrops of the terrestrial Wealden strata with its contained sauropod remains (e.g. Martill and Naish, 2001); they provided some of the earliest comprehensive descriptions, by eminent geologists (e.g. Fitton, 1847), of the change from terrestrial to fully marine deposition (e.g. Wach and Ruffell, 1991) within the Lower Cretaceous and near vertical exposures of the Chalk succession (e.g. Mortimore et al., 2001) represented in the south of England. The Chalk, of course, forms the central topographic spine of the island, provides the ‘backbone’ of this geological diamond (Fig. 3) and is a very visible manifestation of part of the structural development of the island. The northern part of the island comprises the most complete Palaeogene succession in northwest Europe (e.g. Forbes, 1856; King, 2006). It includes many type sections within the coastal exposures, including the internationally renowned sections at Alum Bay and Whitecliff Bay (e.g. Curry 1954, 1957) at the western and eastern ends of the island, respectively. The geology of the island has been imaged in many ways (e.g. photography, aerial photography, seismic surveys) since the earliest years of investigation, each providing a new insight into the make-up of the island. Most recently, the spectacular low-flying HiRes airborne survey has provided new sets of data that add significant detail to earlier national surveys. Three papers, White and Beamish (2011)(high-resolution magnetic survey), Beamish and White (2011a) (electrical conductivity), Beamish and White (2011b)(radiometric) provide preliminary insights into the analysis of this data, with each dataset being tested against the modern geological field surveying conducted during the Isle of Wight Project. Overlying these bedrock strata is an enigmatic patchy spread of Quaternary superficial deposits that hold keys to unlock our understanding of the ancient Solent River, a river/estuarine/marine system that has formed a significant feature in the landscape for at least the last 600,000 years (Bates and Briant, 2009). This Quaternary sequence, here on the island, in the immediate offshore and more widely on the mainland, carries a signature of numerous cold/warm climate cycles, widely fluctuating sea-levels and some of the earliest glimpses of the hominid occupation of the British Isles.

The full bedrock succession known from the island is illustrated in Fig. 6 a and b and Fig.8.

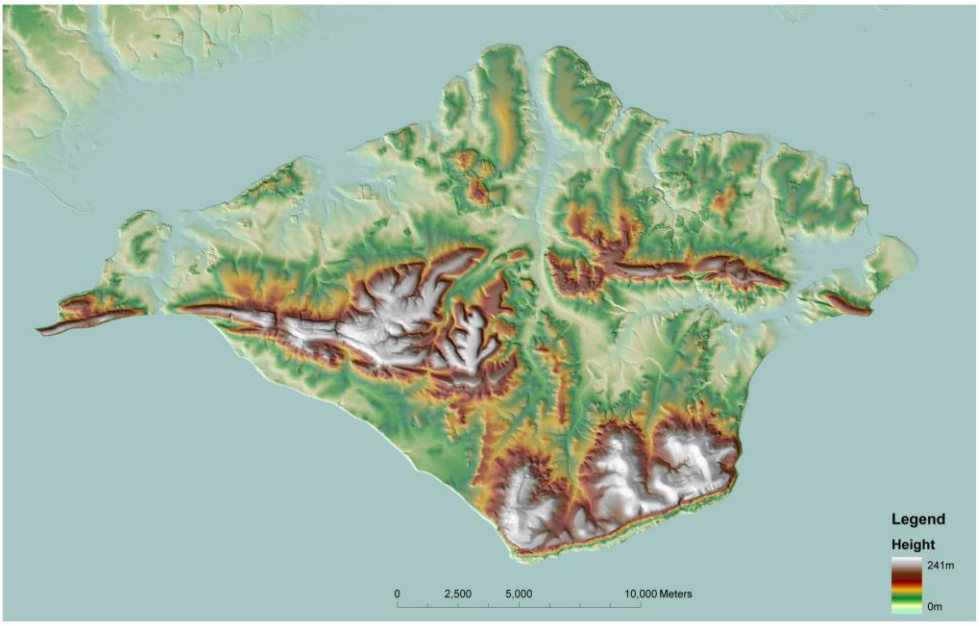


Fig. 3. The topography of the Isle of Wight as demonstrated in a shaded relief digital terrain model.

This image has been created from the NEXTMap Britain Elevation dataset and has been produced by exaggerating the terrain by a factor of two. A colour ramp has then been applied, areas are coloured according to height values. Sea level is light blue, low heights of around 10 to 20 meters are coloured light green, the colour ramp then passes though dark green, yellows and browns. The maximum heights (c. 250m) are coloured white.

The attitude of the strata, that make up the steeply dipping central spine of the island, are testimony to the significant tectonic event (the Alpine Orogeny) that formed the many east – west mountain chains within southern Europe around 23-14 million years ago (Ziegler, 1981, 1990). These Isle of Wight features (Underhill and Paterson, 1998; Evans et al., 2011) are in themselves a reversal of extensional tectonic events that created the Wessex Basin during the preceding Mesozoic (Stoneley, 1982; Chadwick, 1986, 1993). This Wessex basin story itself has its origins within the Palaeozoic and carries a history of continental collision and division that offers an insight into the development of the major continental masses through time.

In summary, this is quite a story for such a small piece of the English landscape.

2. Structure and basin development

Structurally, the Isle of Wight falls within the Wessex Basin (Stoneley, 1982; Chadwick, 1986, 1993) which extends over most of southern England, south of the London Platform and Mendip Hills (Fig. 4). This sedimentary basin preserves a thick succession of Permian/Triassic to Cretaceous rocks and is underlain at great depth by Palaeozoic strata in the Variscan Foldbelt (see Fig. 4 and 5) (Penn et al., 1987).

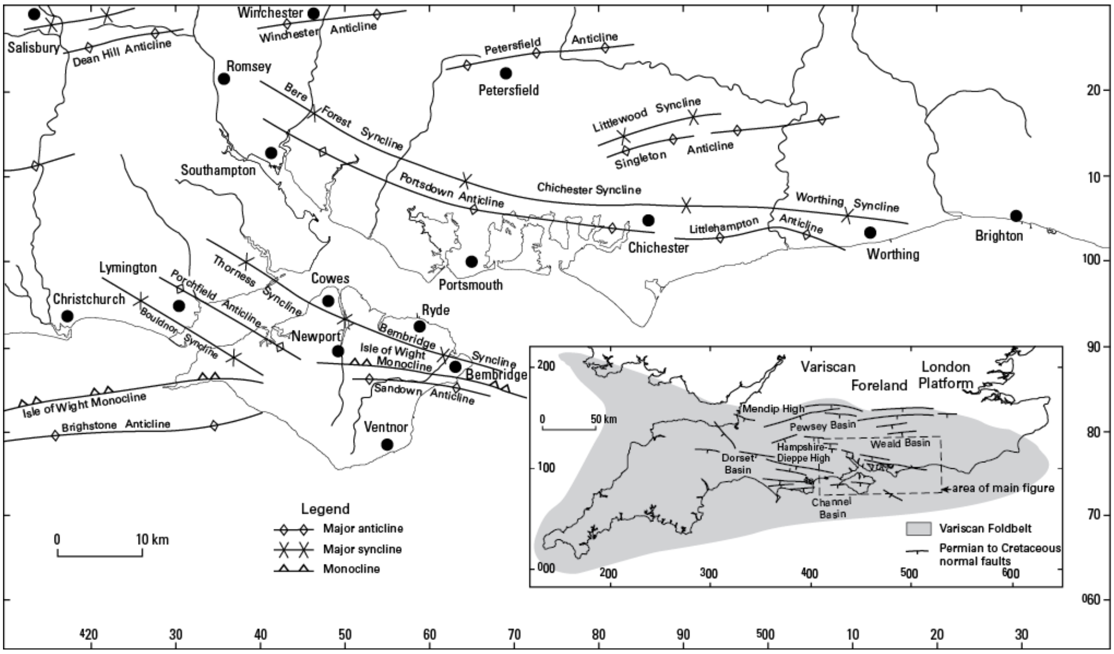


Fig. 4. The structural setting of the Isle of Wight within the broader Wessex Basin (inset), and a generalised view of the surface structures based on the currently available geological map.

The Palaeozoic (or Variscan) basement preserves an imprint of deep-seated structures that were initiated when the continental masses of Gondwana and Laurentia (Laurussia) collided (i.e. the Variscan Orogeny) to create the supercontinent of Pangea (Holdsworth et al., 2006). This period of deformation culminated at about 299 Ma at the end of the Carboniferous period. As a consequence of this collision the rocks of the Variscan Basement were weakly metamorphosed and are cut by several major, shallow southward-verging, northward-compressing thrust zones and north-west-oriented wrench faults that have been identified principally from seismic reflection data. These thrusts form an important feature in the subsequent tectonic development of the region.

A major period of stability, erosion and, eventually, continental red-bed deposition ensued through the Permian into the Triassic period; subsequent to which, the first stages of the break-up of the supercontinent of Pangea commenced within the Jurassic period. In the southern England (Wessex) region the break-up process was effectively related to the opening (extension) of the Central Atlantic Ocean between the supercontinents of Laurasia and a dividing southern continent (South America and Africa plates). During the Cretaceous period, the break-up of Laurasia into the North American and Eurasia continental masses resulted in further extension as the early North Atlantic Ocean opened from the south (Holdsworth et al., 2006). This Jurassic-Cretaceous crustal extension was accommodated on faults developed above the Variscan basement thrusts as a series of generally southward-throwing normal faults, creating half-graben-like structures (Chadwick, 1986; Penn et al., 1987). The largest of these faults divide the Wessex Basin into a series of sub-basins and within this district the Weald and Channel sub-basins are separated by the Hampshire–Dieppe High (also known as the Cranborne–Fordingbridge High) (Fig. 4 inset). This high is effectively represented by the northern part of the Isle of Wight and the immediately adjacent mainland; the northern boundary of the high lies along the Portsdown–Middleton faults on the mainland, with the southern margin represented by the monoclinal structures (Purbeck – Wight Structure) that form the spine of the island.

The early development of half-graben structures in the southwest of the Wessex Basin (the Dorset ‘sub’-Basin), outside of the area described herein, preserves thick Permian red-bed facies strata. Further extension developed these half-graben structures towards the northeast and younger Triassic red-bed facies strata are preserved more widely beneath southern England and the Isle of Wight (Ruffell and Shelton, 2000 and references therein).

As basin extension continued into the Jurassic (200-145 Ma), coupled with a progressive, but cyclical, rises in relative sea-level, marine successions were developed widely within the Wessex Basin as the greater accommodation space became available. This extension continued throughout the Early Cretaceous (145-99.6 Ma) although an early phase of low relative sea-level resulted in terrestrial deposition (the Wealden Group) prior to a return to marine deposition. Throughout this long period of extension, the intervening structural highs and some of the larger extensional faults became more influential on sedimentation. Stratigraphical units suffered thickness attenuation or even severe erosion, at various times, depending on the relative sea-level, the degree of movement on individual faults and the accommodation space available. By the Early Cretaceous separate successions were developed within the Weald and Channel sub-basins (see for example Chadwick, 1986; Penn et al., 1987; Gale, 2000a; Hopson et al., 2008) and onlap, particularly onto the London Platform and the Hampshire – Dieppe High, can be demonstrated within the Wealden, Lower Greensand, Gault and Upper Greensand successions of the Lower Cretaceous.

A further period of regional subsidence, but apparently with considerably less fault movement, and a sustained relative sea-level rise within the Late Cretaceous [99.6-65 Ma] resulted in the highest relative sea level in Earth's history. This high sea-level, coupled with a greenhouse earth, saw a relatively uniform and thick Chalk Group deposited widely in this region and across the continental shelf areas adjacent to the ever-widening North Atlantic (see Gale, 2000b and references therein). Although it must be stated that there is a growing weight of evidence (e.g. Mortimore and Pomerol, 1997; Evans and Hopson, 2000; Evans et al., 2003, and references therein) to show that some variations in chalk lithology and thickness within the Chalk Group can be attributed to further tectonic influence and not just to eustacy as previously supposed. Global sea-level fall at the end of the Cretaceous resulted in erosion of parts of the uppermost Chalk and the development of a pre-Cenozoic unconformity. This was effectively the end of the Wessex Basin as a major structural/depositional unit. However, structural disharmonies preserved in the succession within the Wessex Basin continued to influence sedimentation and tectonics through to the present day.

Marine and fluviatile deposition in Paleocene to Oligocene times, on the shallow margin of a geographically more limited, shallow, subsiding Palaeogene (59-23 Ma) or 'Tertiary' North Sea Basin (King, 2006), was followed by the onset of a compressive tectonic regime during the early- to mid-Miocene (Alpine Orogeny, c. 23-14 Ma). There is evidence that Palaeogene compression as a precursor to this main event did initiate the Isle of Wight structural uplift as exemplified for example in Gale et al. (1999) and Newell and Evans,(2011). This major compressional event effectively reversed the sense of movement on the major bounding faults of the older Wessex Basin resulting in the structural inversion of earlier basins and highs. Compression was for this region essentially from the southeast, a direction at a slight angle to the preserved structures of the Wessex Basin. This slight obliquity of the maximum convergence forces to the existing Wessex Basin fault structures led to differential movement along each of these major faults. These pressures also perhaps emphasised the north-west – orientated wrench faulting inherent in the underlying strata and there is evidence of block and 'scissor' faulting particularly associated with the most significant structures (e.g. the Isle of Wight structure).

The Alpine compression event effectively separated the London and Hampshire Palaeogene basins onshore in southern England. The event created the reverse-faulted monoclinal structures best exemplified by the Hog's Back in Surrey (and its westward extension south of the London Platform) and the Purbeck – Wight structure (that extends westward through the Isle of Wight into the Ballard Down and Isle of Purbeck structure) (King, 2006). Between these two obvious structures, the compression also formed a series of regularly-spaced, roughly east – west-trending strongly asymmetric anticlines and synclines that are somewhat less striking topographically. The northern margin of the Wessex Basin is the London Platform a long term feature founded on the stable block of the East Midlands Microcraton. Maximum uplift during the Alpine Orogeny, exemplified by the Weald Anticline, is estimated at about 1500m (Simpson et al., 1989).

The structure of the island (Fig. 4) is most spectacularly represented by the vertical Chalk features at the eastern (Culver Down/Whitecliff Bay) and the western end of the island (Scratchell's Bay/the Needles/Alum Bay). These represent a continuation of the Purbeck – Wight structure that on the island, is termed the Isle of Wight Monocline. This is effectively two en-echelon monoclinal features (the Brighstone and Sandown strongly asymmetric anticlines, often referred to as variously monoclines, structures, or flexures in the literature) separated by a flatter-lying chalk downland, central to the island, that is now regarded as a classic fault ramp area (Evans, et al., 2011; Mortimore, 2011b). The monoclinal structures have been regarded as simple, if extreme, examples of folding (at least extreme in terms of southern England). The observations of the BGS team and a reinterpretation of the available seismic data has indicated that the two monoclines of Sandown and Brighstone are not simple structures; they are now reinterpreted as 'failed' monoclines with significant reverse faulting on the northern limb. A new interpretation and evolution of the Isle of Wight Monocline structure is given by Evans, et al. (2011).

3. An outline of the lithostratigraphy of the Island

3.1. Concealed geology

There are nine deep boreholes (Cowes 1, Sandhills 1 and 2, Norton, Wilmingham, Chessell 1, Arreton 1 and 2, and Bouldnor Copse) that prove the strata concealed at depth beneath the island (see Fig. 1 for location of these boreholes, and Fig. 6a). Each was drilled in the hope of finding a hydrocarbon reservoir similar to that at Wytch Farm to the west. Whilst some showed hydrocarbon traces none proved sufficiently productive to develop further. However, each provides vital clues to the nature of the strata at depth and together they demonstrate the differences between the preserved sequences on the Hampshire-Dieppe High and the Channel Basin and offer an insight into the development of the structure itself and the timing of oil migration. Of the nine wells, seven are north of the Isle of Wight structure and only Arreton 1 and 2 are south of the structure.

The nature of the Palaeozoic basement is revealed in six of these boreholes that penetrate Devonian strata. Purplish red to red claystone, siltstone and fine-grained sandstones preserved in five of these, north of the monoclinal structure, and Arreton No.2 proving purplish ortho-quartzite to the south. All are weakly metamorphosed. None of the sequences have, so far, yielded reliable dates but comparison of the lithologies encountered with other dated successions at outcrop and in boreholes indicates a Devonian age. The map of Smith (1985) considers the island to be underlain in the north by undivided Devonian with the area south of the structure interpreted as Devonian to Carboniferous in age. Known occurrences of Carboniferous rock in the region are the Culm Basin of Devon, the Ferques Inlier in the Pas de Calais in northern France, and at depth elsewhere in south-east England (e.g. the Kent Coalfield). There is, however, no direct evidence of rocks of Carboniferous age being present beneath the island and to the south of the island commercial hydrocarbon wells also only prove Devonian strata (Hamblin et al., 1992)

A succession of Triassic strata overlies the Devonian in the deep boreholes. These occurrences represent the easternmost margins of the thicker Triassic successions found in the Wytch Farm hydrocarbon reservoir and Dorset Basin to the west. The thickest and stratigraphically most complete development of the Triassic, and thick Permian strata within the Wessex Basin, is seen on the coast between Torbay and Sidmouth (Edwards et al. 1999 and 2004).

The paper by White and Beamish (2011) compares the UK baseline magnetic dataset with that obtained from the spectacular low-level HiRES air-borne survey during September 2008. The reinterpretation of that survey and older data, beneath the southern extremity of the island and within the offshore area some distance to the south, indicates that significant magnetic bodies originally thought to be between 2 and 5 km depth (and therefore within the Variscan basement succession), may well be higher within the sedimentary pile. This interpretation suggests that such bodies are within Permian(?) to Triassic strata and at shallower depths of about 1 km. They may therefore be equivalent to the ‘Exeter Volcanics’ of Permian age in the Dorset Basin (Knill, 1969; Cornwall et al., 1990).

The depth to the pre-Permian basement across the island is indicated in Fig. 5, based on Smith (1985).

Seven of the nine deepest wells prove Triassic strata and up to 450 m is known Representatives of the Sherwood Sandstone Group, Mercia Mudstone Group and the Penarth Group are all present in varying thicknesses. Very earliest Triassic strata are known in offshore boreholes to the west and southwest of the island, and are equated to the Aylesbeare Mudstone Formation of Dorset/Devon. The Triassic represents a long period of arid continental red-bed deposition over a low-relief desert plain. Early fluviatile sandstone-dominated successions characterised by the Sherwood Sandstone Group give way upwards to clay- and silt-dominated strata of the Mercia Mudstone Group (MMG). The MMG represents deposition in distal alluvial and playa-lake environments with thin sandstones representing a variety of channel and crevasse splay deposits (Hounslow and Ruffell, 2006). The close of the Triassic saw the widespread Rheatian transgression above the basal surface of which the Penarth Group is represented in this area by a relatively thin, limestone-dominated, shallow marine succession. Worldwide this boundary marks one of the five major extinction events in Earth’s history

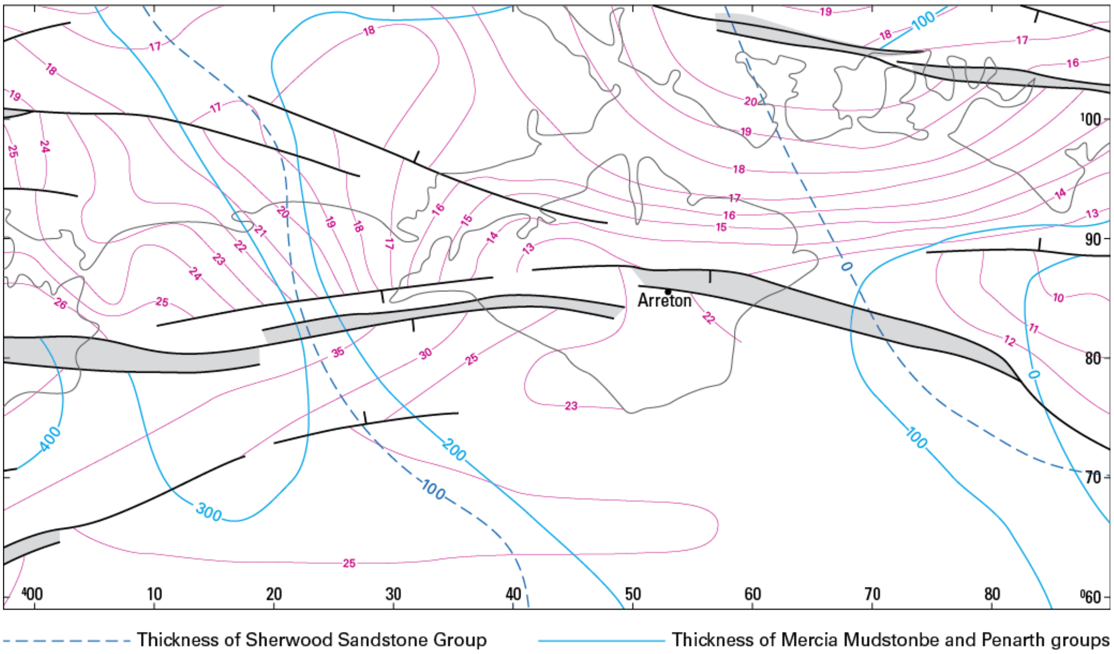


Fig. 5. The depth to the pre-Permian basement beneath the Isle of Wight (modified from Smith (1985) (red contours in hundreds of metres). Thickness contours for the Sherwood Sandstone Group and the Mercia Mudstone and Penarth groups are indicated by lines in blue (modified from Hamblin et al., 1992).

A representative full succession (Fig. 6a) of the buried Jurassic strata was proven in the Arreton wells south of the Hampshire – Dieppe High where 1438 m of strata (Arreton No.2) is encountered. A further 100 m attributed to the Purbeck Group, that includes the Jurassic/Cretaceous boundary, is proven in this borehole beneath a full Wealden succession. To the north, over the Hampshire – Dieppe High itself, the

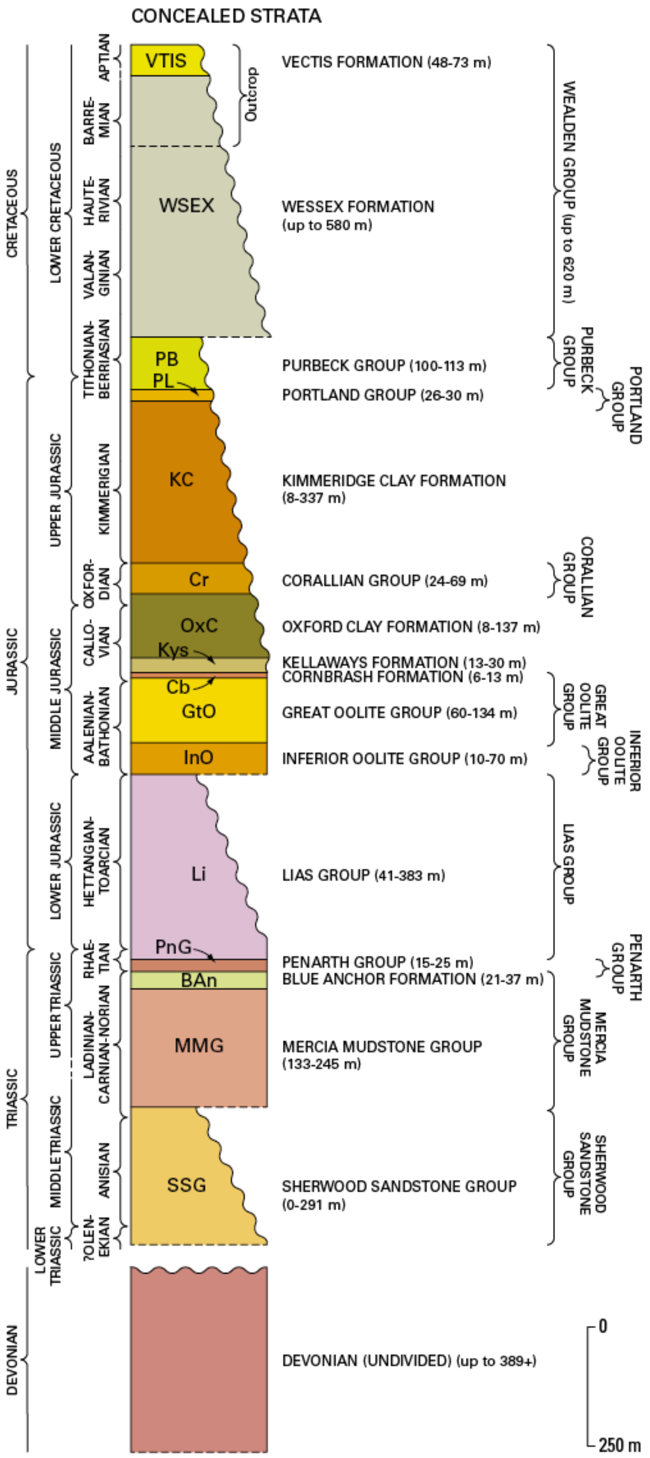


Fig. 6a.The concealed bedrock strata encountered beneath the Isle of Wight.

Aptian/Albian Lower Greensand unconformity cuts out or oversteps the Wealden Group, which was perhaps never deposited over the high, and cuts down deeply through the Jurassic succession such that the Monks Bay Sandstone Formation (see Hopson et al., 2011) rests with some discordance on the Cornbrash Formation. Local stratal thicknesses suggest that up to 716 m of Jurassic strata are absent in the Cowes borehole.

Lithostratigraphical units can be closely correlated with the successions at depth across the Wessex Basin and at outcrop in Dorset and the Cotswolds. The Jurassic succession of limestones, lime-mudstones and mudstones demonstrates a return to fully marine conditions following the red-bed deposition of the Triassic. For the most part sedimentation rates throughout the Jurassic kept pace with the rising sea-level and the new accommodation space made available during the extensional phases of the Wessex Basin. The palaeoenvironment was maintained in broad shallow shelf sea platforms. Notwithstanding this general uniformity of deposition there is some marked thickening of individual stratal packages across some of the extensional faults within the basin demonstrating that the timing of movement was not uniform basin-wide (Penn et al., 1987 and references therein). The Purbeck Group, that spans the Jurassic/Cretaceous boundary, is characterised by shallow lagoonal limestones, shell detrital limestones and palaeosols together with significant anhydrite beds indicating the gradual change of palaeoenvironment towards peritidal and terrestrial deposition of the Wealden Group as relative sea-level fell during the earliest Cretaceous.

3.2. Lower Cretaceous

The full thickness (620 m) of the Wealden Group (Fig. 6a) is present in the Arreton borholes but only the upper third is represented at outcrop along the spectacular southwest coast, with even less of the succession visible north of the seawall within Sandown Bay. The group is divided into two formations. The Wessex Formation and the Vectis Formation as defined by Daley and Stewart (1979) to replace the terms Wealden Marls and Wealden Shales, respectively, adopted in the earlier survey memoirs.

The Wessex Formation has no formal subdivision on the island (Fig.6b), and it is not fully exposed, although a number of named beds (principally the dividing sandstone units) are described from the continuous coastal section in Compton Bay and Brighstone Bay (Daley and Stewart, 1979; Stewart, 1981a, b; Insole and Hutt, 1994). The type section of the formation is at Bacon Hole and Mupe Bay on the coast in Dorset to the west. The formation, as seen on the island, is considered to be deposited in freshwater and floodplain environments, characterised by a Mediterranean-type climate, with high-sinuosity rivers (note that the extensive braided rivers of this region at the present time are maily a consequence of human activity reducing the vegetation cover, and are not typical of ‘natural river activity’ of Mediterranean regions), ephemeral ponds and lakes that suffered significant major flooding events and dessication. Flood events are represented by the more widespread sandstone beds within the succession.

The continued exposure of the group into Brighstone Bay on the southwest coast of the island provides the type section (west from Atherfield Point) for the Vectis Formation. Its constituent three members are defined (from the base, these are the Cowleaze Chine, Barnes High and Shepherd’s Chine members) and can be easily traced on this coastline (Daley and Stewart, 1979; Stewart, 1981b; Stewart et al., 1991; Wach and Ruffell, 1991). The Vectis Formation shows considerably more evidence than the preceding Wessex Formation of very shallow lacustrine or lagoonal deposition with fluctuating salinities. Although mainly freshwater, interbeds representing short-lived marine incursions occur commonly towards the top of the succession, providing an early glimpse of the return to fully marine conditions within the overlying Lower Greensand Group. This changing environment and the Ostracoda present, that in this case span this Barremian/Aptian boundary, is discussed in Wilkinson (2011a). The group, particularly the Wessex Formation, is internationally famous for its included saurian remains including some forms unknown from anywhere else in the world (Martill and Naish, 2001; Insole and Hutt, 1994).

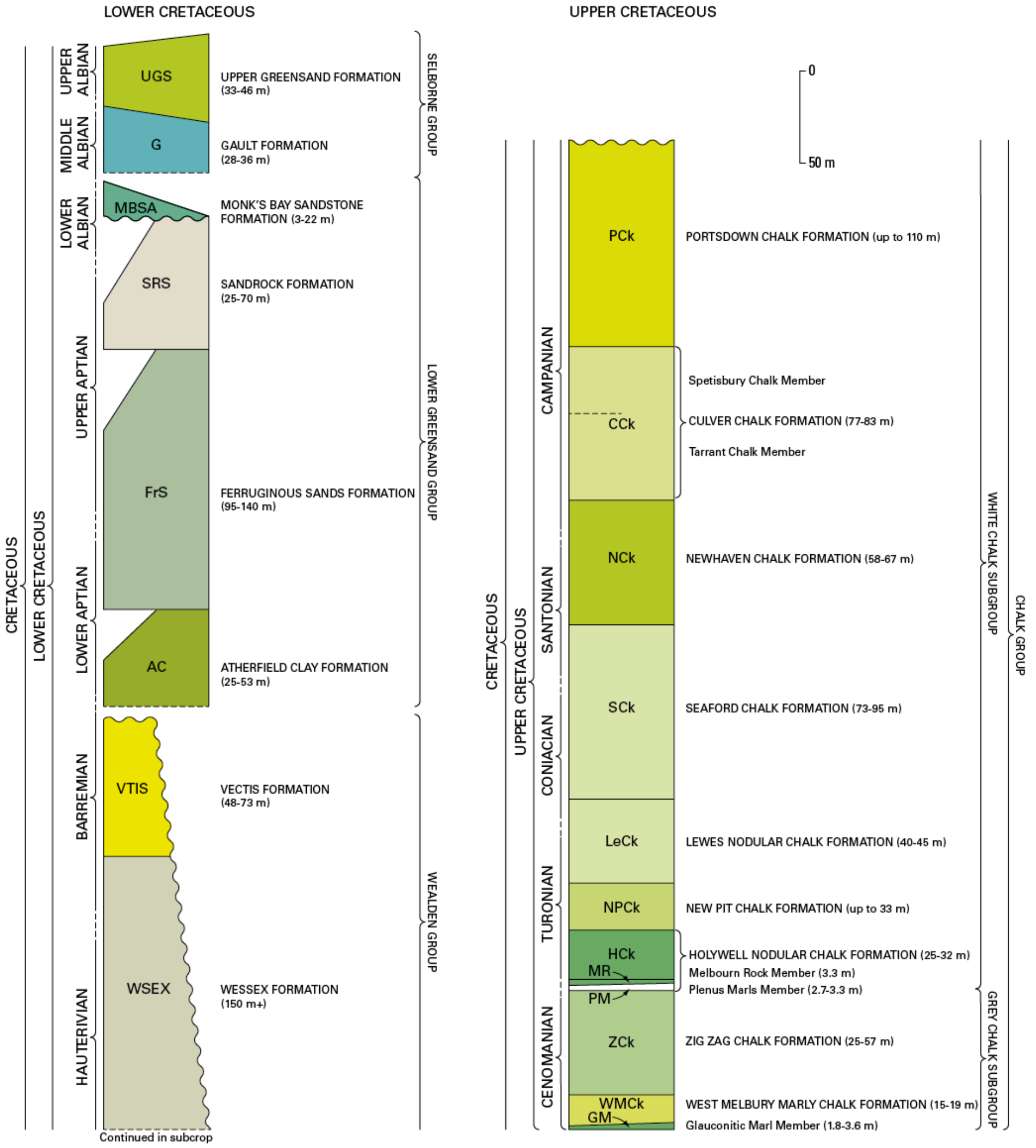


Fig. 6b. The Cretaceous strata at outcrop in the Isle of Wight.

The Lower Greensand Group (Fig. 6b) has its own terminology, at formation level and below, developed for the exposures on the island and repeated in part to the west in Dorset. The original classification of the group was by Fitton (1847) who divided the ‘Lower Greensand’ into a large number of beds and ‘groups’ that he amalgamated into six ‘divisions’. That scheme was simplified in later survey memoirs (Bristow, 1862; Reid and Strahan, 1889; White, 1921) where the four units of Atherfield Clay, Ferruginous Sands, Sandrock and Carstone were defined by reference to the units of

Fitton. It must be noted that the southwest coast that formed the type sections for Fitton's classification suffers rapid coastal erosion and the original sections are no longer present. The current exposures are between 70 and 100 m further inland. The best descriptions of the succession, as currently seen, are summarised, from various authors (see below), in the GA guide No. 60 by Insole et al. (1998) whilst the biostratigraphy of the group is described for the island, and correlated more widely, in Casey (1961). The four units have been given formal formation status but the Carstone Formation has subsequently been renamed the Monk's Bay Sandstone Formation (Hopson et al. 2008; and formally defined in Hopson et al., 2011) from its parastratotype on the island. The group represents a return to marine conditions following the major early Aptian transgression (Simpson, 1985; Wach and Ruffell, 1991; Dike, 1972a, b) and overall the palaeoenvironment represents deposition in mainly shallow seas with increasingly strong tidal influences through time. The shallow shelf seas with slow sedimentation rates and storm-scouring are characteristic of the Atherfield Clay Formation. The Ferruginous Sands Formation demonstrates deposition over an ever-more shallowing shelf with coastal sand-waves and troughs together with localised omission surfaces and common firm-ground development. Further regression during the deposition of the Sandrock Formation is characterised by estuarine conditions cross-cut by sub-tidal channels. A further period of erosion followed quickly by transgression that deposited the iron-rich coarse sandstones of the Monk's Bay Sandstone Formation represents, essentially, the basal member of the Albian transgression.

The Selborne Group (Fig. 6b) is the formal term adopted by the BGS (Hopson et al., 2008) to include the Mid and Late Albian strata throughout southern England, and reintroduces the concept of Jukes-Browne and Hill (1900) of a Selbornian Stage (Selbornian Beds in White, 1921) albeit modified with the epithet, group, as the lithological counterpart. On the island the group is represented by the Gault Formation and the Upper Greensand Formation. Traditionally across much of southern England the boundary between the two has been considered as indistinct and the unsatisfactory term Passage Beds has been utilised widely for a variable thickness is sandy clays intermediate between the Gault and Upper Greensand. On the Isle of Wight these intermediate beds are considered as the lower part of the Upper Greensand Formation (unit A of Jukes-Browne and Hill, 1900). Comparison of the group with successions on the mainland in Wiltshire and Dorset and around the western closure of the Weald Anticline, as described for example in Bristow et al. (1995, 1999) and Hopson et al. (2001), demonstrate distinct similarities with the succession on the island. The group is fully marine in origin with the Gault representing mid- or outer-shelf deposition and the Upper Greensand representing eastward-prograding shallower-water deposition. At this time the influence of the Hampshire – Dieppe High waned as relative sea-levels rose once more and fully representative, though thinner over the high, successions of the group are found at outcrop across the southern part of the island and at depth in the north of the island. Aspects of the foraminiferal biostratigraphy of this succession and the basal part of the overlying Chalk Group derived from examination of core and samples from the Ventnor No 2 borehole are discussed in Wilkinson and Hopson (2011).

The Gault is generally sandier than its equivalents described from around the Weald and is considered to have been the result of slow sedimentation below wave base at water depths of about 100 to 200 m. The succession at Redcliff has been recently described by Gale et al. (1996) adding detail to the geographically more widespread descriptions of the formation, including those known from elsewhere on the island, in Owen (1971). The Upper Greensand is variable and the current geological map of the island depicts an unnamed chert-rich unit towards the top of the succession that essentially corresponds to a unit E (within units A to F) as defined in Jukes-Browne and Hill (1900). The formation is regarded as forming within shallow offshore shelf and lower shoreface zones related to a prograding shoreline. The group has a significant influence on the landscape and built environment over the southern part of the island with the Gault often providing a significant plane on which many landslides are initiated, hence its old local name of 'blue slipper' (discussed in Jenkins et al., 2011) and parts of the Upper Greensand being utilised as the most significant locally derived building stone on the Island (Lott, 2011).

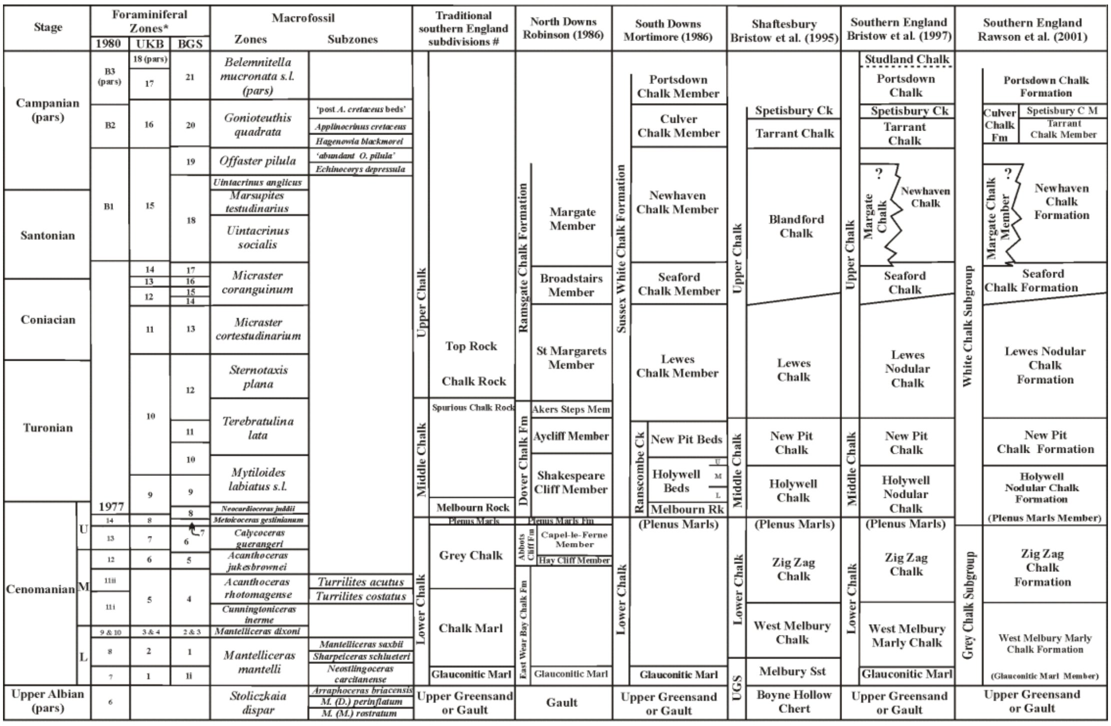
3.3. Upper Cretaceous

The Late Cretaceous is frequently described as a greenhouse world. It is characterised by high global temperatures, high concentrations of atmospheric carbon dioxide and high relative sea levels with little evidence of polar ice caps. Temperatures and sea-level peaked during the late Campanian and a chalk sea was established from Ireland through to Kazakhstan. Land masses were distant and terrestrial input very limited such that pure white biogenic micritic limestone (chalk) was deposited over wide areas in seas considered to be, generally, up to 200 m deep. A indication of this greenhouse world and its effect on the Chalk biota is reflected upon in Wilkinson (2011b) in describing periodic 'blooms' of the calcareous micro fossil *Pithonellid* through the White Chalk Subgroup . The foraminiferal biozonation utilised by BGS, as surveys have progressed since the early 1990s over southern England, is published in its entirety (Wilkinson, 2011c) for the first time in a major journal.

The Chalk Group (Fig. 6b, Fig. 7) and can probably be said to be the lasting view of Isle of Wight geology held by many of the visitors to the island, with the steeply dipping chalk cliffs of Culver Down in the east and the spectacular, internationally famous and much photographed Needles promontory to the west. These cliffs are of course the most significant manifestations of the Purbeck – Wight Structure in southern England. Culver Down forms the headland from Sandown Bay northward through to Whitecliff Bay (the Whitecliff GCR site of Mortimore et al., 2001) and provides the finest continuous section of the group (traversable with great care at the lowest spring tides) in southern England. The much described succession can be matched with equally spectacular cliffs between Beachy Head and Brighton on the mainland (see Mortimore, 1986; Mortimore et al., 2001 and references therein) and provide a key to lithostratigraphical correlation of the group. The Culver Down section is mirrored in the west of the island from Compton Bay through to Alum Bay. This western section is continuous for over 8 km, but is impossible to visit over large parts (most notably below the long stretch of Tennyson Down to West High Down), at even the lowest tides. In the far west, at the Needles promontory, it is possible to visit the higher part of the Chalk succession by boat to Scratchell's Bay and this is described in Hopson et al. (2011). The paper provides, for the first time, a full lithostratigraphical log of this important section that has been the subject of numerous PhD theses, as indeed has the Culver Down headland, each characterising a particular aspect of the chalk succession (e.g. Montgomery, 1994; Swiecicki, 1980).

Whilst the seminal works of Jukes-Browne and Hill (1903, 1904) and of Rowe (1908) had formed the basis for the description of the chalk for decades, and provide a great deal of important detail, the upsurge in interest in Chalk lithostratigraphy across southern England particularly within the 1980s (e.g. Mortimore 1979, 1986; Robinson, 1986) has led to a comprehensive reappraisal of the Chalk Group (e.g. Rawson et al, 2001; Hopson, 2005; Mortimore 2011a). This reappraisal can be can readily be applied to the Isle of Wight (Mortimore et al., 2001: Mortimore, 2011b; Farrant et al., in press) developing earlier works such as that by Hancock (1975), Jefferies (1963) and Kennedy (1969). The development of Chalk terminology is illustrated in Fig. 7.

The Culver Down /Whitecliff section and that around the Needles have provided internationally important reference sections for the study of various aspects of the Chalk Group. Particular attention has been paid to biostratigraphy (Hart et al., 1987, 1989; Prince et al., 1999, 2008) as well as, for example, the PhD thesis of Swiecicki (1980) mentioned above; geochemistry (Jarvis et al., 2001); carbon and oxygen isotope studies (Jarvis et al., 2006; Jenkyns et al., 1994); sequence stratigraphy (Gale 1996; Grant et al., 1999); magneto-stratigraphy (Montgomery, 1994); studies of Milankovitch cyclicity (Gale,1990; Ditchfield, 1990); and global stage-boundary correlation (Gale et al., 1995).



#Traditional Chalk subdivisions after Jukes-Browne and Hill (1903, 1904, for example). UGS = Upper Greensand; *s.l.* = *sensu lato*. Not to scale
*Foraminiferal zones after Carter and Hart (1977), Swiecicki (1980), Hart et al. (1989) (UKB zones) and Wilkinson (2000) (BGS zones).

Fig. 7. The Chalk Group terminology for the Southern Chalk Province

The finer division of the Chalk Group has permitted a greater degree of certainty in respect of the structure of the island and more widely on the mainland (e.g. Mortimore and Pomerol, 1991, 1997). Evidence for considerably more faulting cross-cutting and parallel to the chalk outcrop (see Evans et al., 2011), has been identified during the survey. These substantiate those identified in articles by Nowell (1987, 1995) and

Mortimore (2011b), but with additional faults identified during the recent survey. This structural control of outcrop is further demonstrated when making geomorphological interpretations of the subtle crest-orientation changes (that mimic the underlying bed strike) along the steeply dipping ridges to the east and west of the island.

3.4. Palaeogene

There is a significant unconformity, representing a time-gap of about 15 million years, between the youngest known Chalk on the island and the basal beds of the overlying Reading Formation. It is assumed that chalk deposition continued from the late Campanian (the youngest Portsdown Chalk Formation is perhaps c.72 Ma on the Island) up until at least the youngest Maastrichtian as there is evidence of chalk of this age being present beneath the English Channel (Hamblin, 1992). It is still unclear as to whether chalk sedimentation continued into the Danian in this area (as in the North Sea Basin) as the Channel Basin was affected by minor episodes of ‘early-Alpine’ inversion at this time as precursors to the major inversion in the mid-Miocene. This may well be the time when erosion of the chalk was initiated in this region. Evidence for assuming the area of the Isle of Wight being land for a short time is provided by the basin-wide peneplanation of the Chalk and progressive overstep of the Reading Formation over younger chalk (e.g. on the Isle of Wight 25 m of the Portsdown Chalk is missing from the Culver Down succession whilst it is present in Alum Bay); the major sea-level fall in the early Thanetian; and the absence of sediments representative of the early and much of the late, Paleocene. The evidence for the Cretaceous/Tertiary (K/T) boundary events at around 65.5 Ma is entirely absent from England and Wales so we have no sediments in which to study another one of the major extinction events in Earth’s history. The greenhouse climate continued into the Paleocene and through into the mid-Eocene, with a marked thermal maxima identified at the Paleocene- Eocene boundary (the PETM). From the beginning of the Mid-Eocene the climate began to cool through to the Terminal Eocene Cooling Event (the TEE) marked by the Eocene/Oligocene boundary. All of these major climatic events can be studied in the rocks exposed on the Isle of Wight.

The outcrop and exposures of the Palaeogene of the Isle of Wight offer the most extensive and complete succession (Fig. 8) available in the UK and is a principal site for investigation in northwest Europe. The strata represent about 20 million years of deposition covering the Paleocene to early Oligocene in the western margins of a basin that extended into the North Sea, but at times may have been connected to the southwest with the North Atlantic. The succession on the island is characterised by strata laid down on the margins of a shallow sea in a fluctuating transgressive/ regressive cyclic regime that has resulted in complications in the lateral correlation of strata over the width of the island.

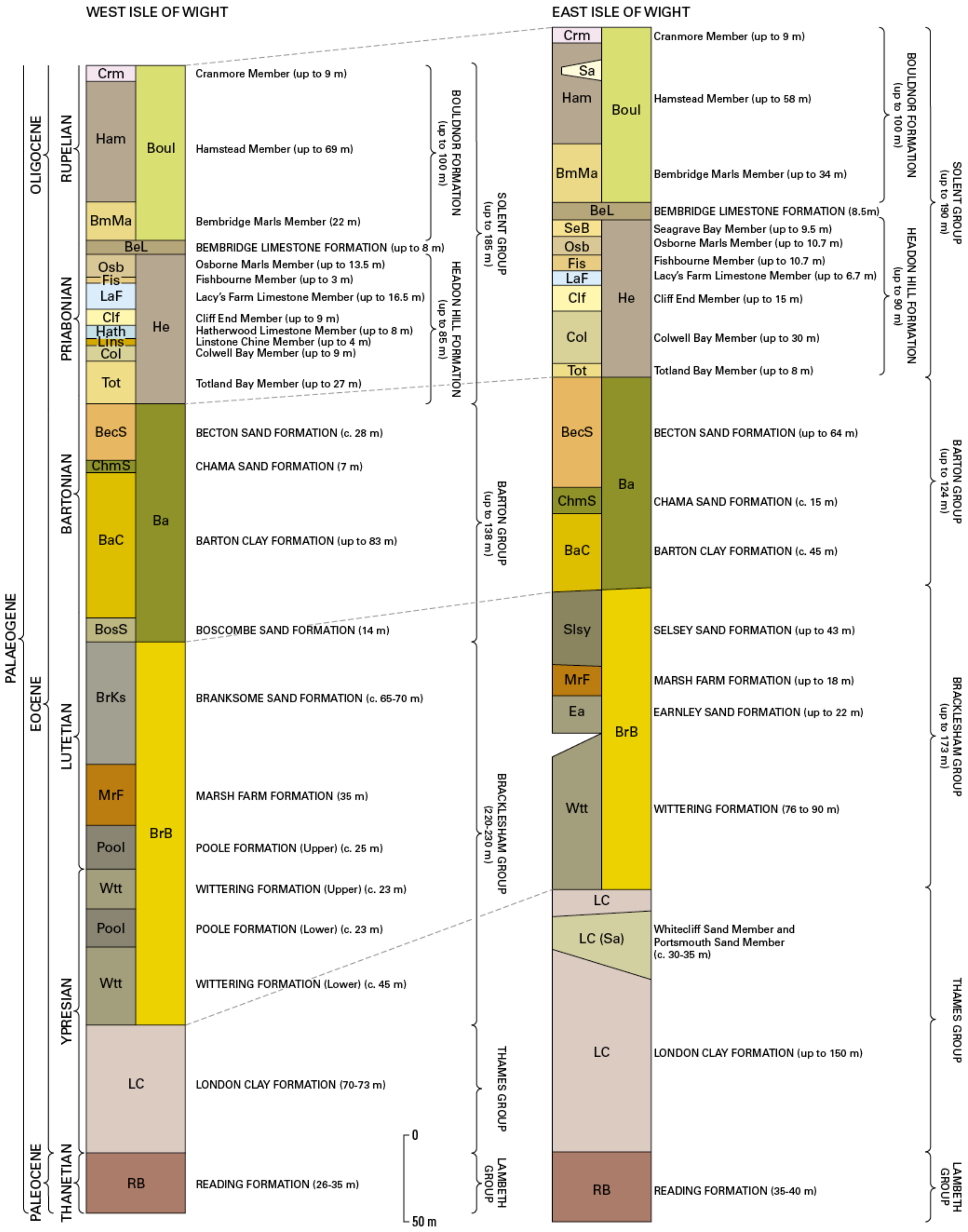


Fig. 8. The Palaeogene strata at outcrop on the Isle of Wight.

The rocks contain evidence of many environments from shallow marine, beach, tidal flat, coastal marsh and lagoon, estuary, river and lake reflecting the relative position of the fluctuating shoreline through time. The succession has been described and interpreted at length within the literature with the texts of Daley and Edwards (1974, 1990), Edwards and Freshney (1987), Insole and Daley (1985), King (1981), and Plint (1982, 1983) being most prominent. These are summarised in the GA Guide to the Isle of Wight (No.60) by Insole et al. (1998). The Tertiary strata are comprehensively described in King (2006) and the new edition of the Tertiary Special Report of the Geological Society (King, in press). Again 'early-Alpine' inversion may well have affected the successions of the Palaeogene in terms of local emergence and erosion adjacent to the Isle of Wight Structure. From the mid-Eocene one such minor uplift and erosion event adjacent to the Sandown Pericline is discussed by Gale et al. (1999), but further evidence is presented by Newell and Evans (2011) for a younger inversion event that affected the Headon Hill Formation in the northwest of the Island.

A short note on the association of *Nummulites variolarius* and an ostracod assemblage from near Newport by Wilkinson and Farrant (2011d) emphasises the important of micro biostratigraphy in the correlation and environmental interpretation throughout the Palaeogene exposed on the island.

3.5. Quaternary

The cover of Quaternary superficial deposits on the Isle of Wight is enigmatic being an incomplete succession, with a patchy distribution and with few reliable dates available to researchers until recently. The outcrops on the Isle of Wight have received scant investigation and the succession of events is only really discernable by reference to the more extensive deposits on the adjacent mainland to the north. There is considerable debate as to the age of the units and direct correlations still carry considerable doubt. Notwithstanding this, the island has some important sites that help to unravel the story of the island's Quaternary history, their contribution to the Solent River story and the British Quaternary stratigraphy as a whole. A broad interpretation of the classification of the succession and its relationship to the more widespread Solent River deposits on the mainland is summarised on Fig. 9. This interpretation is likely to form the basis of the classification shown on the new Special Geological Sheet, due to be published in 2012, that will carry considerably more detailed outcrop patterns and a more appropriate interpretation of the superficial deposits. An outline appraisal, as seen from the perspective achieved during the recent survey, is presented here, incorporating current knowledge and based also on a simple appreciation of relative elevation, the lithology of the deposits and their artefact content (Fig. 10). Even this outline, briefly expanded upon below, will be open to considerable debate and it to be hoped that the Isle of Wight Quaternary succession may receive more attention following the publication of the new map.

The general concept of terrace aggradation as propounded in the works of Bridgland (1994, 1995, 1996) provides a clear method of development for each terrace cycle and points to a complex relationship of fluviatile deposits and environments through cold, temperate and back into cold climatic cycles. A complication, only briefly touched upon in the 'Bridgland model', is the interplay of periglacial remobilisation and slope deposition particularly during the down-cutting events as the rivers respond to relative land uplift. All falling base levels appear to be complicated with both incision, until the sediments transported from the upper part of the catchment arrive, and then aggradation as the stack of sediment is built-up in the lower part of the catchment. This is a period in each cycle during which exposed slopes are in their most unstable

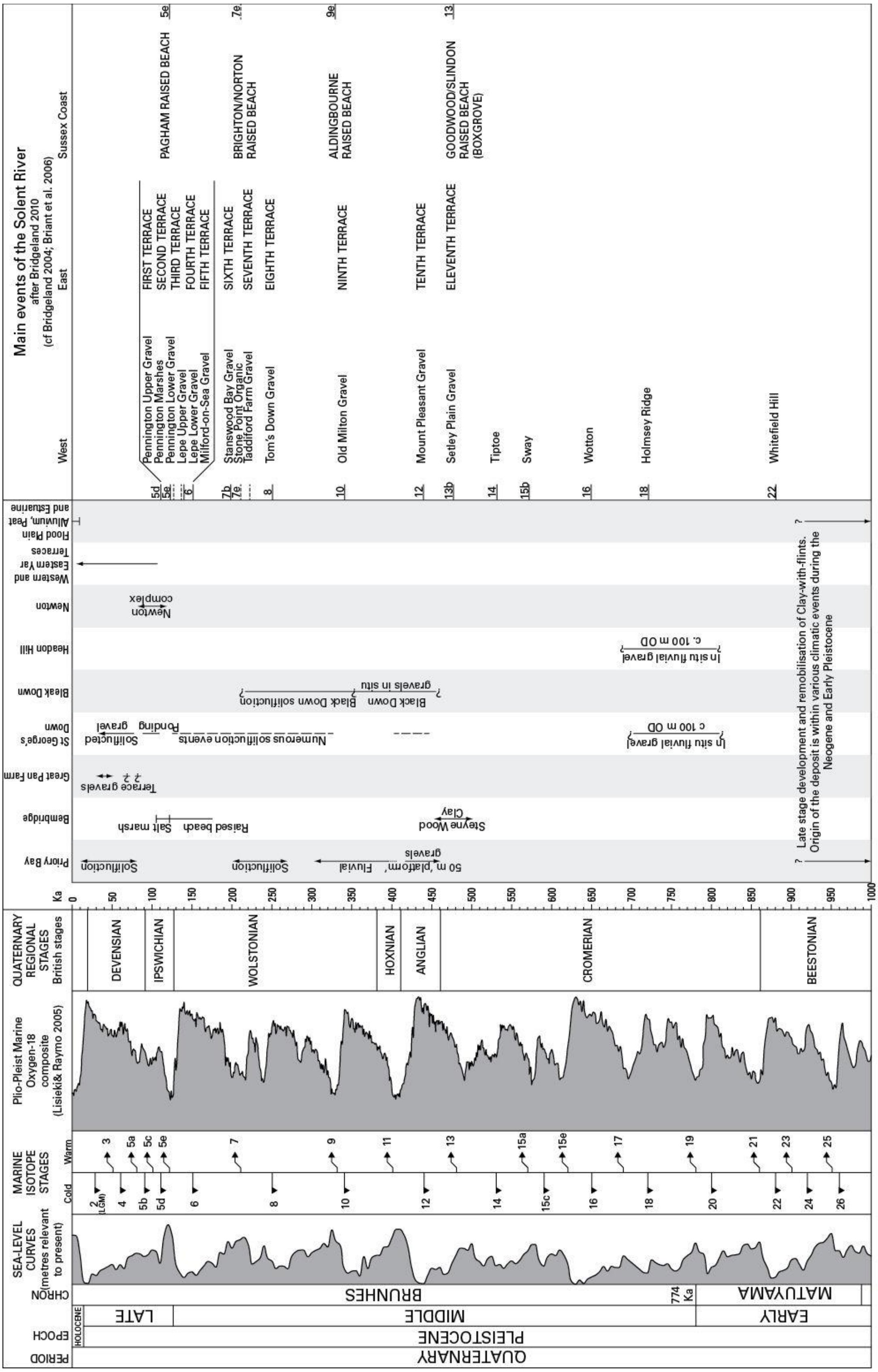


Fig. 9. The outline of the Quaternary succession on the Isle of Wight and it's relationship to the Solent River story. Left hand columns derived from Lugowski and Ogg (2011) without revision (note the younger Devensian and younger Ipswichian boundaries are slightly too old).

condition and periglacial (active layer) processes are at their most active. This issue particularly seems to be reflected in the deposits encountered on the Isle of Wight. A further complication is related to the position of the Isle of Wight within the Solent River system in respect to its contemporary estuarine and marine deposits. At times of sea-level highstand the lower-level parts of the Isle of Wight and the Sussex Coastal Plain were inundated; whilst at periods of lowstand deep trenches and fluviatile aggregation were the norm offshore (e.g. Antoine et al., 2003).

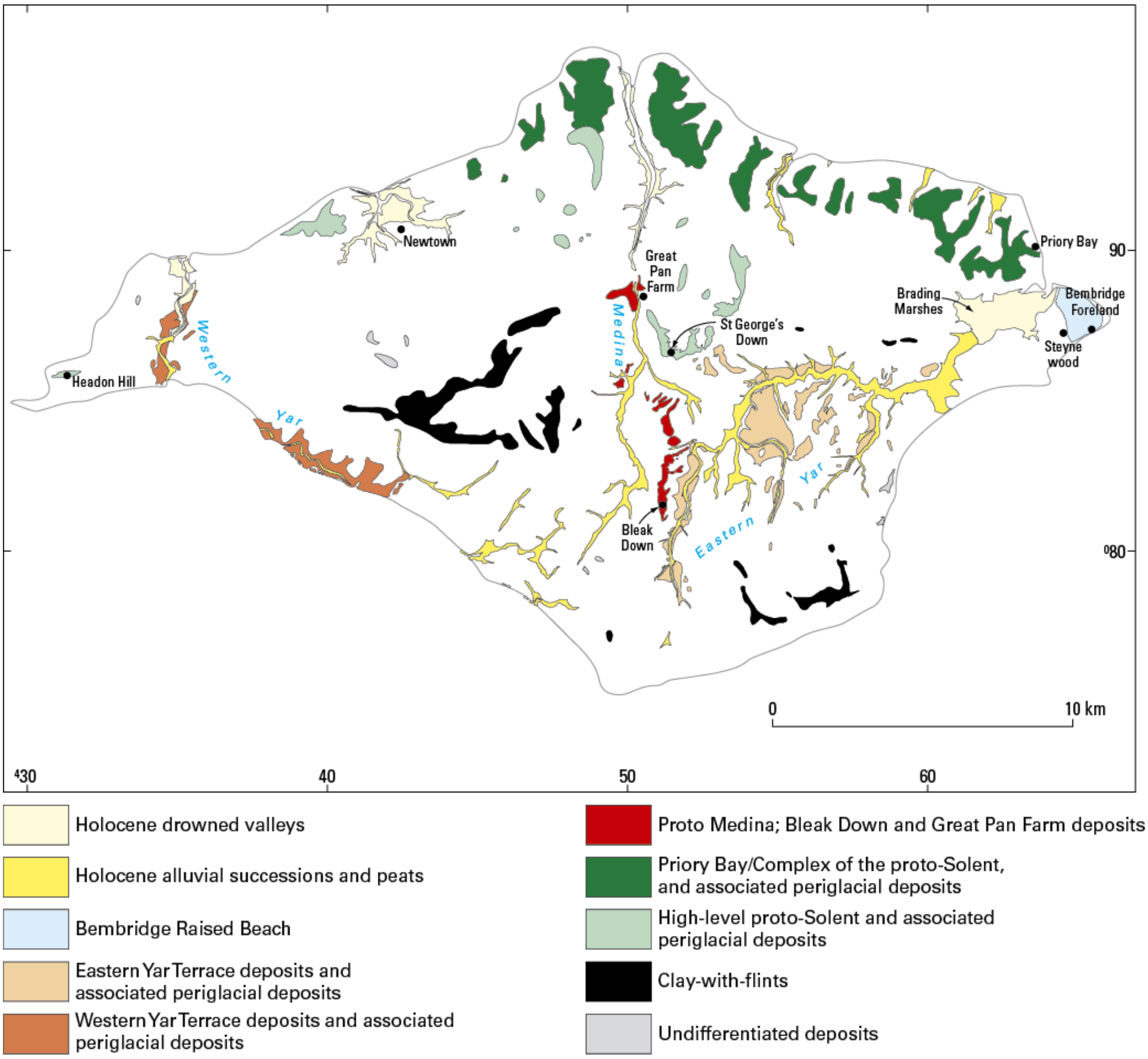


Fig. 10. Outcrops of the Quaternary strata on the Isle of Wight derived from the currently available digital dataset with an interpretation of the relative correlation.

The island contains a wide range of Pleistocene and Holocene deposits that were classified simply on the 1976 published map, and the discussion below utilises these terms for simplicity. Clearly the designation of these, particularly those of the Plateau Gravel, Marine Gravel and Gravel Terraces are an oversimplification and they are now considered as river terrace deposits (undifferentiated) within the current digital map dataset (DiGMap 50) to reflect the dominant depositional process. This is an obvious simplification if topographic height, alone, is considered. The recent survey has demonstrated, even within individual outcrops that the history of deposition is difficult to unravel. With, in many cases, original and sometimes in themselves complex cross-cutting fluvial deposits being either partially or completely remobilised during one or more gelifluction events.

Three sites, Priory Bay, Great Pan Farm and Bleak Down can be regarded of national importance because of the abundant Palaeolithic human-made artefacts derived from them. The deposits at Priory Bay, Great Pan Farm, Bembridge Raised Beach and Steyne Wood provide relative dates that act as a framework within which the relative age and context of other deposits can be placed.

Clay-with-flints

The oldest deposit on the island is the 'Angular Flint Gravel of the Downs' (White, 1921) that is essentially a local facies of the Clay-with-flints (Hodgson et al., 1967, and references therein) as seen on the mainland (the term Clay-with-flints will be applied to the new geological sheet). It is assumed to have a similar mode of formation over an extended period in the late Neogene and early Pleistocene, and, as a consequence, it was probably formed through a number of climatic phases. The Clay-with-flints *sensu stricto* (Hodgson et al., 1967) is a residual rubified stony clay deposit created by the modification of the original Palaeogene cover and progressive dissolution of the underlying Chalk. The basal surface of the deposit approximates to the sub-Palaeogene unconformity but this is much modified by dissolution of the underlying Chalk with karstic features in evidence in most exposures. There is evidence from the new survey that relatively in-situ Palaeogene sediments, generally completely concealed by the Clay-with-flints, may well be preserved in solution features on this sub-Palaeogene surface (one example was cleared and logged during the survey from a shallow exposure on Brighstone Down [SZ 431 849]).

Part of the deposit has been re-mobilised in cold phases during the late Neogene and early Pleistocene and this has been described by others (Hodgson et al., 1967) as Clay-with-flints *sensu lato*. It shares many characteristics with Clay-with-flints *sensu stricto* but is found at levels adjacent to or below the sub-Palaeogene surface and the contained flints are predominantly angular rather than nodular. This re-mobilised unit may include cryoturbated, aeolian sand units, as observed on the mainland (e.g. Frenchen et al. 2003, Hopson, 1995), and perhaps by their presence allude to correlation with more extensive Early Pleistocene wind-blown deposits that are a feature of coeval successions on the continent. In addition, further remobilisation, as the landscape was denuded throughout the Pleistocene, has developed an 'apron' of angular gravelly, sandy clays at lower topographical levels. These late-stage remobilised materials are generally preserved on steeper slopes below the base level of the Clay-with-flints and were considered as separate slope deposits during the new survey. They are considered to be predominantly periglacial in origin and may also have a poly-phase development.

Plateau Gravel and Marine Gravel

On the mainland to the north the term Plateau Gravels was originally applied to the 'staircase' of deposits within the New Forest and adjacent to Southampton Water. These are all now considered as fluvial aggradations of an extensive Solent River Catchment that drained much of the western and central Hampshire Basin and into east Dorset (see Bates and Briant, 2009 and references therein) over a considerable time period. The main confluent stream (proto-Solent) drained eastward and migrated southward over time, presumably reworking much of the south-bank aggradations of each terrace cycle. This stream graded to very variable contemporary sea-levels that range is from 46 m or more below to about 40 m above current sea-level during the more extreme climatic oscillations. Of course, it is likely that the down-cutting and re-grading of each terrace cycle may be 'incomplete' being overtaken by the next climatic cycle before the streams could remobilise the previous terrace aggradations. This is perhaps most true in the headwater areas of each successive proto-Solent stream.

The Plateau Gravel and Marine Gravel outcrops present along the northeast coast of the Isle of Wight (including the Priory Bay site described below), are also now considered as terrace aggradations within the lower reaches of a proto-Solent River catchment e.g. Wenban-Smith et al. (2009) with some authors suggesting that they also include contemporaneous beach gravels at their eastern end.

The topographically higher Plateau Gravel outcrops shown on the currently available geological sheet and their relationship to the northeast coast deposits and the Gravel Terraces, have received scant investigation since the compilation of the currently published map and memoir (White, 1921). They have been considered either as, older and topographically higher proto-Solent River terrace aggradations, or are the result of deposition by northward-flowing south-bank tributaries of that major stream. Some isolated outcrops designated as Plateau Gravel were discussed in terms of different origins such as the 'coombe out-washes' around Calbourne (White 1921, p. 158). Some may equally be mass movement slope deposits derived from a range of original in situ deposits or even remnants of far-travelled landslide debris. In the older literature, and reiterated in the memoir (White, 1921), there is great play made of the northward fall in the gradient of these patches of the Plateau Gravel and this was interpreted as indicating their derivation as higher-gradient south bank proto-Solent river confluent streams.

It must be said that the designation of a terrace order to these deposits based solely on gradient, and by implication their chronology, is not readily achievable without considerable more investigation. This is due to their very patchy nature, the lack of significant exposure, and the lack or extreme paucity of 'datable' artefacts, faunas and floras. Significantly the Solent Basin does not have the benefit of extra-basin 'exotic' clast influxes such as is seen in the Thames Basin that can act as a marker in the succession of terrace deposits. In addition, as already pointed out for the Clay-with-flints, the Plateau Gravel outcrops are each associated with significant spreads of re-mobilised material. These carry the original well-bedded fluviatile sands and gravels to lower topographic levels as sheets of relatively structureless material. Indeed, these sheets of mass-flow deposits, where they spread over a significant height range, may well disguise topographically distinct terrace aggradations or platforms. This is demonstrated for example in the paper by Farrant et al. (herein) describing the high-level (c. 70-100 m OD) gravels at St George's Down.

The descriptions of the deposits at Priory Bay (Wenban-Smith et al., 2009), at a much lower topographical level (c. 29 m OD) than those on St George's Down, also demonstrates polyphase fluvial deposition and in this case contemporary hominin occupation, as well as interbedded, poly-phase mass flow material. The presence of artefacts (see Loader, 2001, Fig. 7.3 and Fig. 7.5) and the availability of OSL dating at this site provide keys to the age of the complex deposit that is placed between MIS 11 and 9 (367 ka to 216 ka) and by crude comparison with the western Solent River being equivalent to the Old Milton to Beckton Farm terrace successions (see Bridgland et al., 2010). Based on the preponderance of artefacts the deposit may also be in part equivalent in part to the artefact-rich Taddiford Terrace (Terrace 7). The complex of deposits at Priory Bay provides a baseline to help interpret those deposits at a higher level (including conjoined gravelly spreads up to 50 m OD inland from Priory Bay itself) and indicate that the very highest deposits throughout the island are likely to be early Middle Pleistocene (i.e. older than the Anglian) or even Early Pleistocene in age.

The Steyne Wood Clay (Holyoak and Preece, 1983: Preece and Scourse, 1987; Preece et al., 1990) at the eastern end of the island at Bembridge at about 40 m OD is equated with the Goodwood-Slindon Raised Beach of youngest Cromerian Complex age (MIS 13). It has been observed (Wenban-Smith et al., 2009) that the abraded artefacts in the lowest stratigraphical levels at Priory Bay may be derived from the conjoined deposits that rise to 50 m OD immediately inland. On the basis of height alone these ‘50 m’ deposits are considered contemporaneous with or older than the Steyne Wood Clay. Thus it is hypothesised that the in-situ gravels on the platform north-westward towards Cowes and at the height of up to 50 m OD may also be of the same age. It has long been noted that these outcrops of Plateau Gravel/Marine Gravel contain an interbedded sand unit that was regarded as marine in derivation though completely devoid of shell. It was equated to the “Portsdown-Goodwood range of raised beaches” (White, 1921), i.e. the Goodwood-Slindon Raised Beach of modern literature. It is believed that the presence of this sand unit and ‘beach-pebble’ occurrences were originally used on the geological map to differentiate these outcrops into Plateau Gravel and Marine Gravel. However, this sand was observed, during the recent survey, further to the west in temporary excavations in the outcrop around Palmer’s Farm, Wootton [SZ 536 925] and field evidence shows that it is also present around Cowes (it is mentioned at Ruffins Copse [SZ 482 941] west of the Medina in the memoir (White, 1921)). Thus the extended occurrence of this sand unit to the west demonstrates the irrelevance of the original differentiation on the map. Since the Goodwood-Slindon Raised Beach is equated to MIS 13 by e.g. Bridgland et al. (2004) this suggests a correlation of this group of outcrops at 50 m OD to the post-Old Milton Gravel to Mount Pleasant Gravel terrace interval in the western Solent Valley and between Terrace 9 and 10 in the east Solent Valley.

Above this ’50 m platform’ there are outcrops of Plateau Gravel at higher levels (55 to 60, 70 to 80 m OD) north of the central Chalk spine of the island. These are depicted on the currently available map and their presence has been confirmed during the recent survey at Hemstead, around Parkhurst and to the east of Newport. These all show evidence of bedded fluvial gravels, but each is now known to be associated with a variable ‘apron’ of mass flow material that frequently disguises the true base-level of the fluvial component(s) or indeed may have re-mobilised such components completely. It is presumed that the fluvial element of these outcrops can be related to proto-Solent terrace deposition (either within the main stream itself or within southbank tributaries draining into it) and must therefore, by comparison to the Priory Bay site, be attributable to one of the higher-level terraces on the mainland and thus of pre-MIS 13 age and potentially equitable to the Tiptoe to Whitefield Hill terrace aggradations of the western Solent River.

The complex of deposits around St George's Down and northward from Downend comprise in-situ fluvial gravels at around 100 m OD and long periglacial 'tails' spreading down interfluves to the north to levels of 70 and 60 m OD respectively (Farrant et al., 2011). The fluvial gravels have long been considered as being part of a very early proto-Medina, i.e. a south bank tributary of the proto-Solent. It is difficult to date the in-situ, high-level fluvial part of the St George's Down gravels as there is little evidence of a northward gradient suggesting a potential confluent height with the contemporary proto-Solent River. Thus a correlation of the high-level fluvial deposits (100 m OD+) within the St. George's Down Gravels with a western Solent Terrace succession cannot be achieved with any confidence at present. However, since none of the in-situ gravels within this higher-level St George's Down deposit have produced artefacts this single line of evidence suggests they are older than the gravels on the northeast coast and by analogy to the mainland must therefore equate to terraces tentatively assigned to MIS stages 14 and older. Similarly, the associated periglacial deposits are also devoid of artefacts but in this case the deposits are considered to have a very long history of development as the landscape was denuded to successively lower levels and potentially represent periglacial deposition during a number of cold climate phases.

Three other principal spreads of Plateau Gravel are known from the surveys at Headon Hill in the west, at Bleak Down associated with the River Medina headwaters and to the south east of the Eastern Yar.

The Headon Hill outcrop is quite isolated and descriptions from it (White, 1921; Warren, 1900) have been interpreted as being a "fan of rock-waste" (i.e. a 'head deposit') derived from former higher ground to the south but the recent survey regards the deposit as of fluvial origin. The base level of this complex of fluvial deposits is at around 90 to 100 m OD. There are no artefacts known from the original investigations, but Wenban-Smith and Loader (2007) note a single flake in their Appendix 1. Despite the single flint flake discovered at this site the deposit must be of considerable antiquity but any correlation more widely would be speculative.

The Bleak Down outcrop has long been regarded as a high level (a base level of about 80 m to 70 m OD) northward-flowing proto-Medina terrace aggradation and is also noted for its high content of artefacts. The gravels were described in Poole (1934) and he recognised a 'higher terrace' and a 'lower terrace' both with complex internal architectures, as well as determining that the artefacts were of considerable variety, state of preservation and type. Wenban-Smith and Loader (2007) consider that the deposit may be as old as pre-Anglian in age and this would imply that the deposits at the highest level on St George's Down are of even greater antiquity. Quite how these gravels fit within the Quaternary story is difficult to judge and a natural correlation on the basis of the high content of rolled and in situ artefacts to the 'Priory Bay Complex' on the northeast coast would seem possible although highly speculative.

The Plateau Gravels delimited to the south and east of the Eastern Yar at levels between 60 and 20 m OD, may be considered, simply, as the higher-level terrace aggradations of a larger proto-Yar stream system and are likely to contain significant amounts of material derived directly from the southern downs. On the basis of height alone they must all post date the in situ Bleak Down deposits. Thus the speculative correlation of Bleak Down with Priory Bay would place these Eastern Yar terraces at post MIS 9 or much younger (?MIS 6) and lower levels topographically may therefore potentially be equivalent to the Bembridge Storm Beach deposits that have an OSL date of 182ka (MIS 6-7b) at a site on the Foreland (Wenban-Smith et al., 2005). The overlying organic silt at this site provides an earliest Ipswichian MIS 5e OSL date of 129ka.

Terrace Gravels

The gravelly spreads in close association with the present day Medina, Eastern Yar and Western Yar valleys are designated as Gravel Terraces on the current map. In many cases the deposits are very thin but cover wide areas and are closely associated with topographical platforms which also carry remobilised material. Various terrace levels can be differentiated on height above the adjacent streams, but a numbered scheme relative to height applied island-wide would seem inappropriate for these widely dispersed outcrops that relate to different streams each draining to a potentially significantly different base-level. The Gravel Terraces differentiated on the current map include those at Great Pan Farm within Newport and recent studies here demonstrate three terrace levels between 5 and 22 m above the adjacent floodplain. The lowest terrace level has produced *bout coupé* handaxes and Levalloisian material (Poole, 1924) whilst OSL dating of the middle of the three terraces identified here (11-14 m above floodplain level) suggests a date of 50Ka BP, placing that deposit in the Middle Devensian (Oxford Archaeology, 2005).

Alluvial and estuarine deposits

The alluvial deposits associated with the present streams are all considered as of Holocene age and represent an infill of drowned valleys that were cut down to a Late Devensian sea-level lowstand below current sea level. Boreholes in the Eastern Yar succession beneath Brading Marshes near Yarbridge, completed during the survey but as yet unreported upon, demonstrated a succession of alluvial and estuarine silts with significant peat units resting on a chalky flint gravel and in situ Chalk. The deepest borehole proved an un-bottomed 13 metres but a series of boreholes 2km farther inland proved at least 15 m of deposit resting on bedrock. Initial dating results from peat in the boreholes at Yarbridge give ^{14}C dates from 7140 BP to about 4120BP. These results accord reasonably with infill-chronologies of other coastal alluvial sites on the mainland and with those envisaged for the Western Yar (Devoy, 1987).

4. People and Geology.

Humans have interacted with the land we live on for many thousands of years, but it is only since widespread agricultural practices became established, and most significantly since the industrialisation of our economies, that we have had significant disharmonious impacts on the landscapes or where the natural systems of the land have acted to limit our ambition. Underpinning this interaction is the geology beneath our feet. Our greatest demands on the Isle of Wight landscape come from agriculture, the increasing demand for water supply, the need to protect the coastal regions or at least know what mitigation is effective, the natural resources we can exploit, the landslide hazard that is so prevalent on this island and the impact of tourism (including geo-tourism). Four papers in this issue provide overviews on aspects of our action and reaction in respect of the island's geology. Booth and Brayson (2011) discuss aspects of geodiversity and geoconservation; whilst Lott (2011) describes the use of natural building stones that provide the vernacular character of different parts of the island. Jenkins et al. (2011) provides an overview of the landslide hazard across the island and emphasises the cause and effects of landslides away from the much studied 'Undercliff' along the southeast coast. Tasker et al. (2011) uses geological knowledge to determine the likely provenance of tesserae found at the Brading Roman Villa and point to a very early use and possible industry based on the locally available tectonised Chalk.

How do we react to our landscape? Much of it is driven by policy-makers under the guise of 'planning' in its broadest sense. Specifically for the Isle of Wight, a large part has been designated as an Area of Outstanding Natural Beauty (AONB) and there are additionally many smaller areas considered as Sites of Special Scientific Interest (SSSI) for both biological (37 sites) and geological (15 sites) reasons. Increasingly there is pressure to designate offshore areas with some form of protection. Infra-structure development is tightly regulated by the IoW Council, particularly where the extensive land-sliding has proved to be so destructive to the built environment, but also to protect the major landscape heritage that makes the island so popular as a tourist destination.

Two passages in the Ward Lock *Illustrated Guide Book to the Isle of Wight* for 1920 show why the island is so popular to both the humble tourist and those who seek to study geology and they attest to the importance of this little geological diamond:

"As a resort of those who make holiday, the Isle of Wight is an embarrassment. Its attractions are so numerous and diverse that the visitor pauses on the shore to weigh the merits of half-a-dozen famous spots" (attributed to an anonymous daily newspaper writer).

"An acquaintance, however slight, with the principles of geology cannot fail to add to the interest and enjoyment of a visit to the Isle of Wight. A former president of the Geological Society (unnamed) remarked that the island 'might have been cut out by nature for a geological model illustrative of the phenomena of stratification'. Advanced students will hardly expect to find in a book of this character any very learned or elaborate disquisition and we must content ourselves with referring them to *A short account of the Geology of the Isle of Wight* by H J Osborne White, an excellent memoir issued by the Geological Survey."

The new Geological Special Sheet and its companion descriptive texts will also satisfy the student of geology and bring our appreciation of the wealth of information very much into the present day. It is to be hoped that these items will also appeal and inspire the interested tourist at the same time.

Acknowledgements

The author would like to thank the reviewer for his comments, corrections and suggestions that have helped considerably in the finalisation of this paper.

The author would also like to thank all of my colleagues who have contributed to this volume and for their considerable effort in the prosecution of their skills whilst the Integrated Isle of Wight Project was in existence. Thanks go also to the BGS Drilling crew who completed four campaigns on various sites throughout the island under the guidance of Steve Thorpe and Chris Slater

Considerable assistance to the project has been forthcoming from a number of people whose help is perhaps not represented in the papers herein. I would particularly like to thank, in no particular order, Professor Andy Gale (Portsmouth), Professor Rory Mortimore (Brighton), Professor Steve Hesselbo (Oxford), Professor Malcolm Hart (Plymouth), Professor Ian Jarvis (Kingston), Dr Becky Briant, Dr Rob Scaife, Dr Peter Montgomery, Dr Francis Wenban-Smith, Dr Chris King, Dr Adrian Palmer.

Graham Heard and Jerry Field of Northern Petroleum; Steve Burton and Alan Bulpin of Aggregate Industries (UK) Ltd (Bardon Vectis) for access to St Georges Down; Mike Packman (Southern Water); representatives in various departments of the Isle of Wight Council. Dr Martin Munt formerly Curator of Geology: Museum of Isle of Wight Geology/Dinosaur Isle Museum, Isle of Wight Council and now with The Natural History Museum, London. Robin Lang of the National Trust for the considerable help in access to NT land and for accommodating our drilling rig at various sites; Mr O Hoskyns (Hobbits Farm), Mr R Morgan (Knighton Sand Pit), Dr K Ballard (RSPB, Brading), Mr D Lovegrove (Hill Farm) who all permitted access to our drilling rig.

Mr Mike Forsyth-Caffrey of the Maritime and Coastguard Agency, The Freshwater Bay Independent Lifeboat Crew who saw us safely to Scratchell's Bay, Mr Bill Webb of the Isle of Wight Geological Society, Edwin and Sally Burt who put up with the team over many weeks at their West Standen Farm. Lastly to all of the land owners and the many interested residents and tourists who were amazed at the work we were doing in our daily perambulations over the highways and bye-ways of the island.

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Full Figure Captions

Fig. 1. The outline topography, principal towns and locations of geological interest on the Isle of Wight.

Deep Wells: **1**. Norton 1, SZ38NW18 [SZ 34006 89098]; **2**. Wilmingham 1, SZS38NE9 [SZ 36620 87790]; **3**. Bouldnor Copse 1, SZ39SE1 [SZ 38537 90179]; **4**. Sandhills 1, SZ49SE3 [SZ 45700 90850]; **5**. Sandhills 2, SZ48NE55 [SZ 46129 89850]; **6**. Cowes 1 (Bottom Copse), SZ59SW17 [SZ 50036 94161]; **7**. Arreton 1, SZ58NW2 [SZS 53070 85640]; **8**. Arreton 2, SZ58NW1 [SZ 53200 85800]; **9**. Chessell 1, SZ48NW11 [SZ 40571 85581].

Fig. 2. One of the earliest geological maps of the Isle of Wight taken from Mantell (1847), originally published in 1846 by Henry G Bohn of London.

Fig. 3. The topography of the Isle of Wight as demonstrated in a shaded relief digital terrain model.

This image has been created from the NEXTMap Britain Elevation dataset and has been produced by exaggerating the terrain by a factor of two. A colour ramp has then been applied, areas are coloured according to height values. Sea level is light blue, low heights of around 10 to 20 meters are coloured light green, the colour ramp then passes though dark green, yellows and browns. The maximum heights (c. 250m) are coloured white.

Fig.4. The structural setting of the Isle of Wight within the broader Wessex Basin (inset), and a generalised view of the surface structures based on the currently available geological map.

Fig. 5. The depth to the pre-Permian basement beneath the Isle of Wight (modified from Smith (1985) (red contours in hundreds of metres). Thickness contours for the Sherwood Sandstone Group and the Mercia Mudstone and Penarth groups are indicated by lines in blue (modified from Hamblin, et al., 1992).

Fig. 6a. The concealed bedrock strata encountered beneath the Isle of Wight.

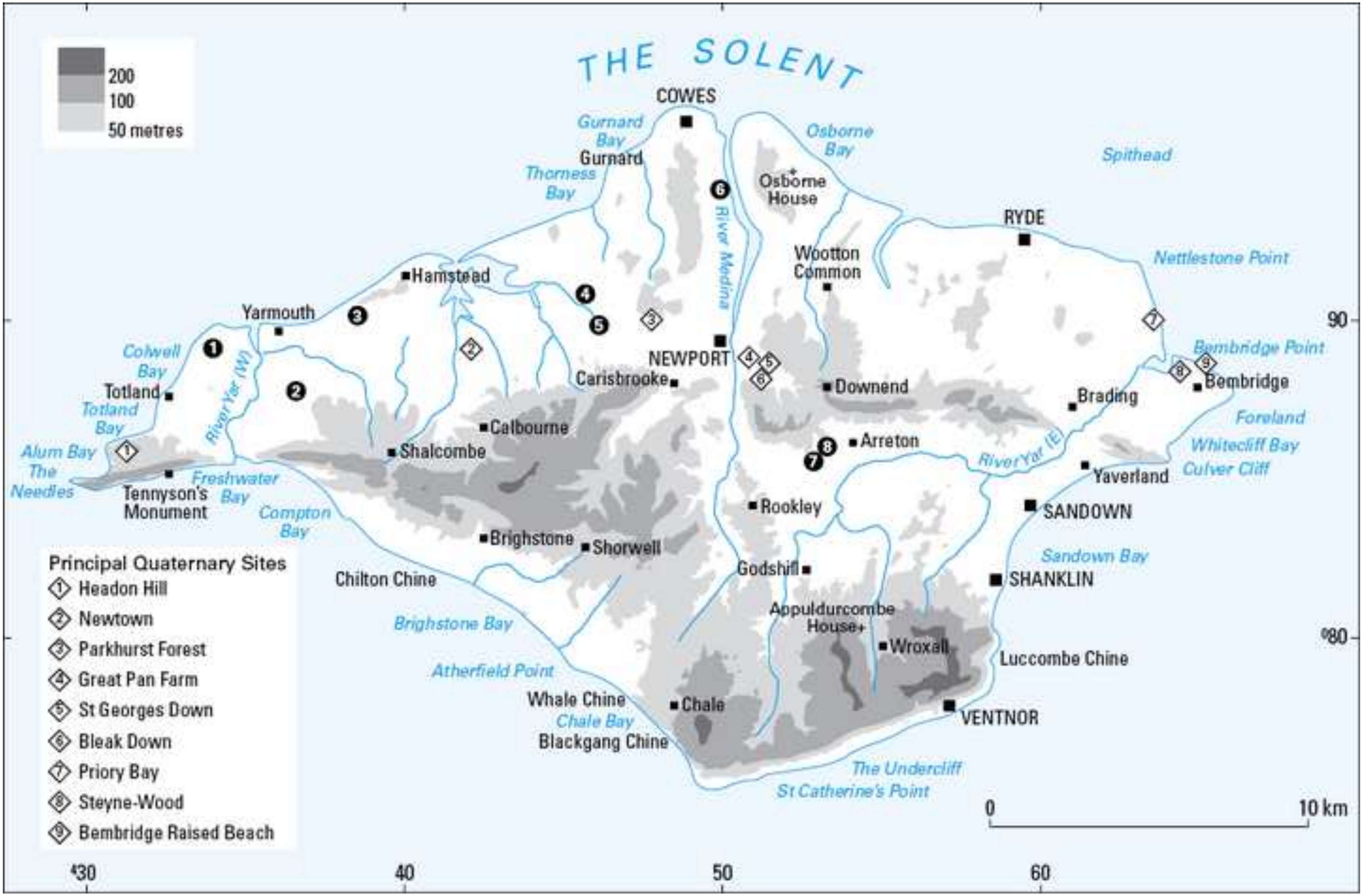
Fig. 6b. The Cretaceous strata at outcrop in the Isle of Wight.

Fig. 7. The Chalk Group terminology for the Southern Chalk Province.

Fig. 8. The Palaeogene strata at outcrop on the Isle of Wight.

Fig. 9. The outline of the Quaternary succession on the Island and its relationship to the Solent River story. Left hand columns derived from Lugowski and Ogg (2011).

Fig. 10. Outcrops of the Quaternary strata on the Isle of Wight derived from the currently available digital dataset with an interpretation of the relative correlation.


THE SOLENT
200
100
50 metres
COWES
Gurnard Bay
Gurnard
Thorness Bay
Osborne Bay
Osborne House
Spithead
River Medina
RYDE
Wootton Common
Nettlestone Point
Hamstead
Yarmouth
NEWPORT
Carisbrooke
Colwell Bay
Totland
Totland Bay
River Yar (W)
Alum Bay
The Needles
Tennyson's Monument
Freshwater Bay
Compton Bay
Calbourne
Shalcombe
Brighstone
Shorwell
Downend
Arreton
Rookley
Godshill
River Yar (E)
Brading
Bembridge Point
Bembridge
Foreland
Whitecliff Bay
Culver Cliff
Yaverland
SANDOWN
Sandown Bay
SHANKLIN
Appuldurcombe House
Wroxall
Luccombe Chine
VENTNOR
Chilton Chine
Brighstone Bay
Atherfield Point
Whale Chine
Chale
Chale Bay
Blackgang Chine
The Undercliff
St Catherine's Point
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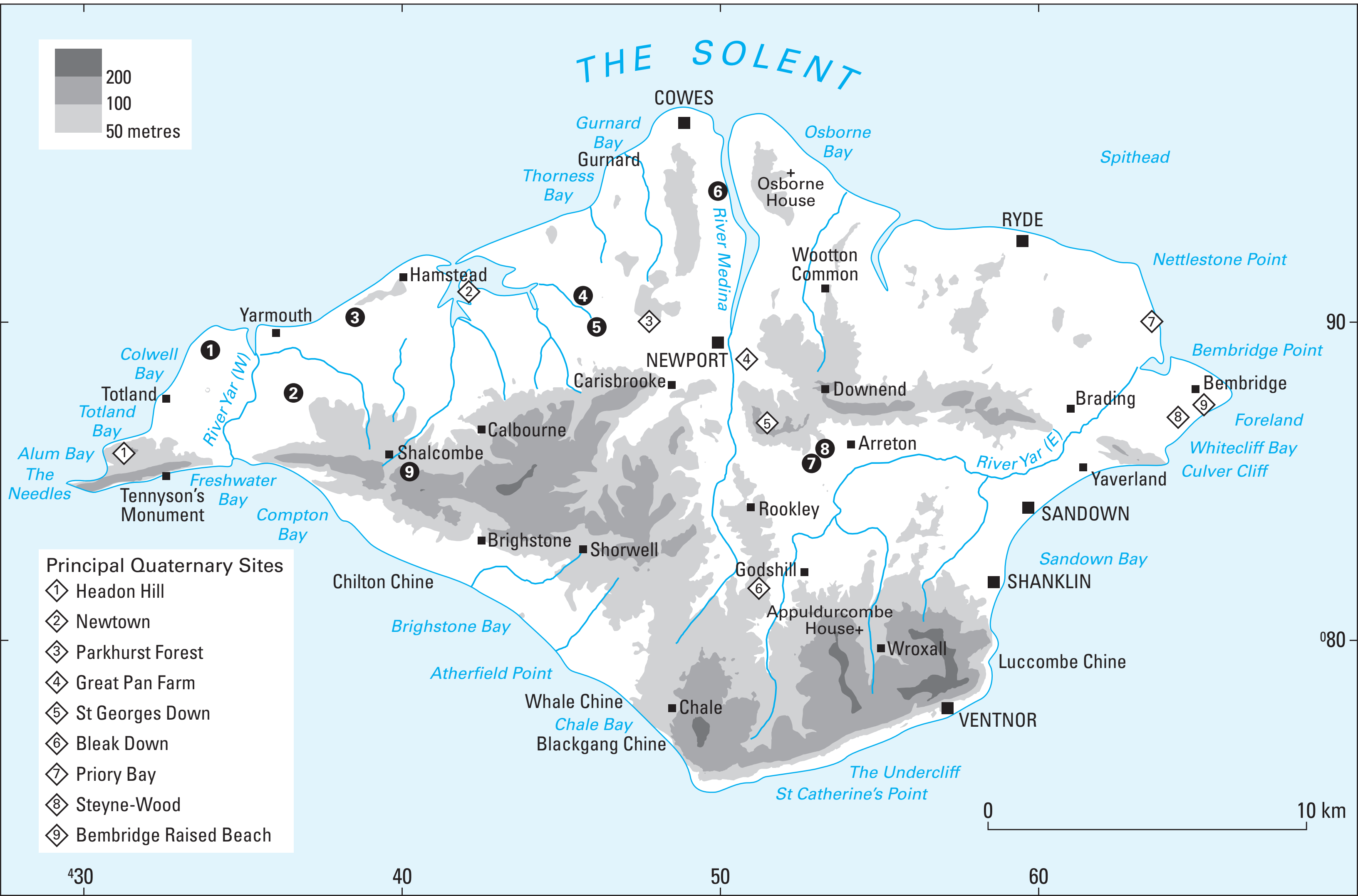
7
8
Principal Quaternary Sites
1 Headon Hill
2 Newtown
3 Parkhurst Forest
4 Great Pan Farm
5 St Georges Down
6 Bleak Down
7 Priory Bay
8 Steyne-Wood
9 Bembridge Raised Beach

Figure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River Medina
Hamstead
Yarmouth
NEWPORT
Carisbrooke
Colwell Bay
Totland
Totland Bay
River Yar (W)
Alum Bay
The Needles
Tennyson's Monument
Freshwater Bay
Compton Bay
Calbourne
Shalcombe
Downend
Arreton
Brading
Bembridge Point
Bembridge
Foreland
Whitecliff Bay
Culver Cliff
Yaverland
River Yar (E)
SANDOWN
Sandown Bay
SHANKLIN
Rookley
Godshill
Appuldurcombe House
Wroxall
Luccombe Chine
VENTNOR
Brighstone
Shorwell
Chilton Chine
Brighstone Bay
Atherfield Point
Whale Chine
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Chale Bay
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Principal Quaternary Sites
1 Headon Hill
2 Newtown
3 Parkhurst Forest
4 Great Pan Farm
5 St Georges Down
6 Bleak Down
7 Priory Bay
8 Steyne-Wood
9 Bembridge Raised Beach
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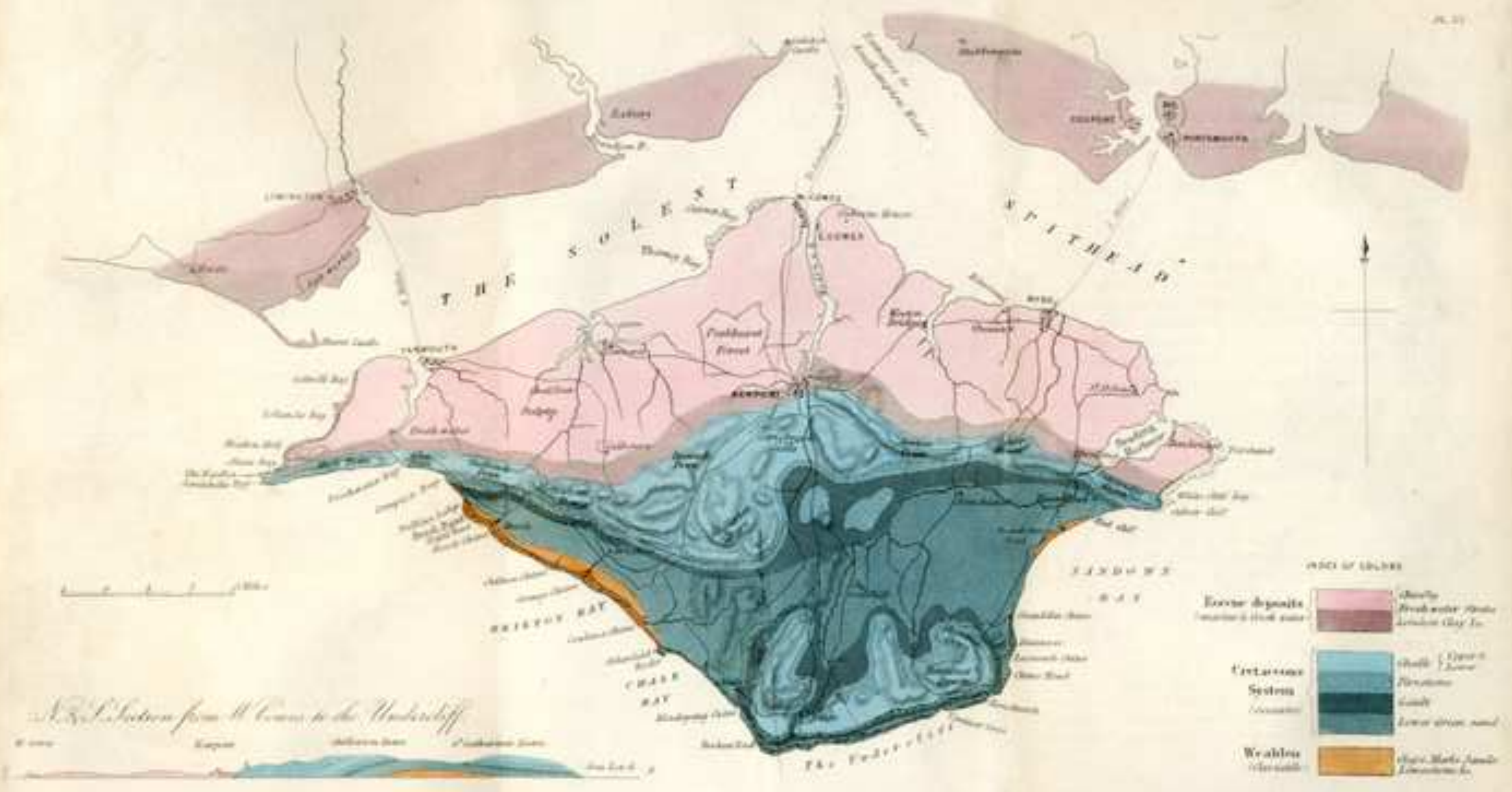
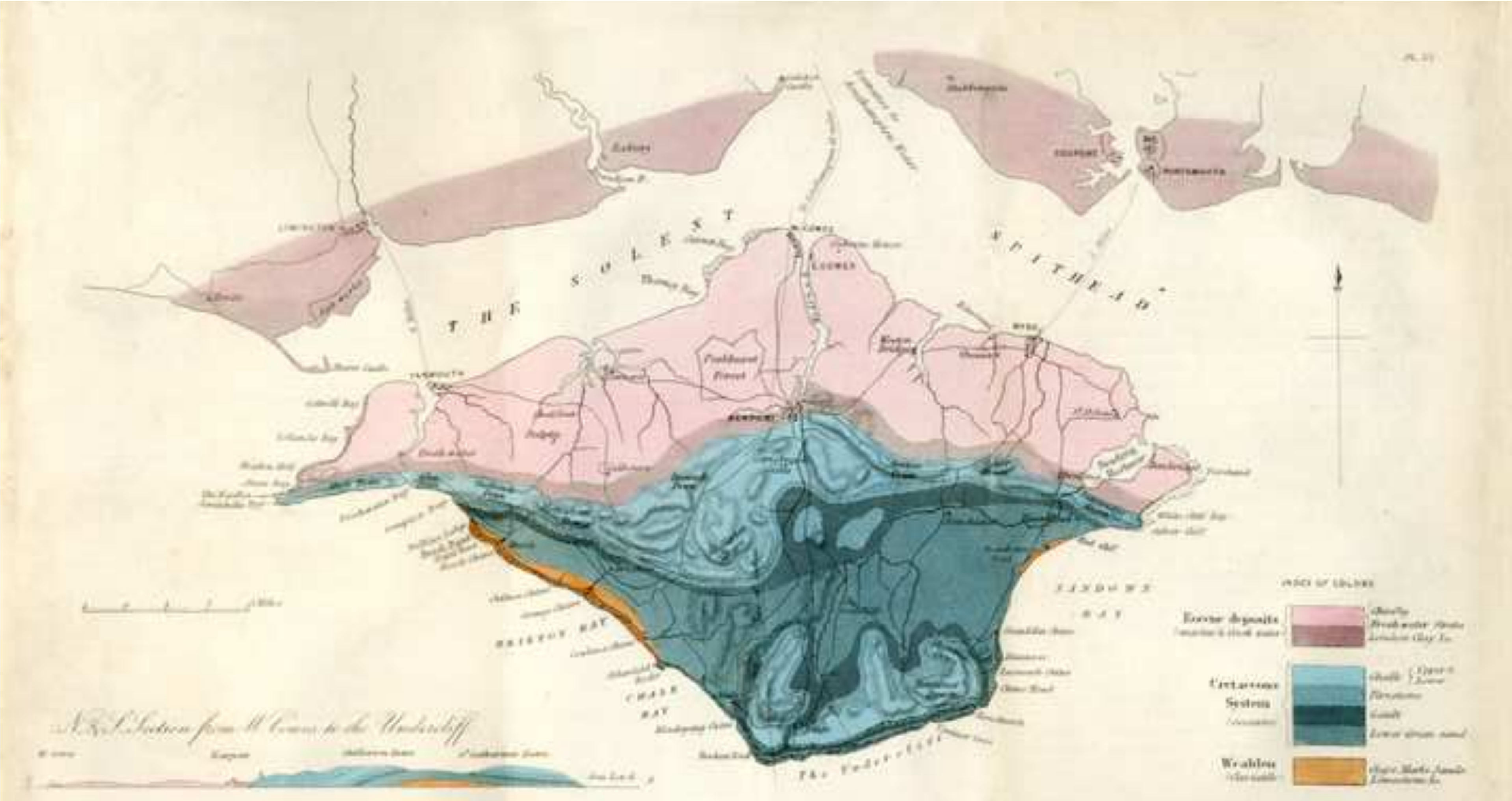


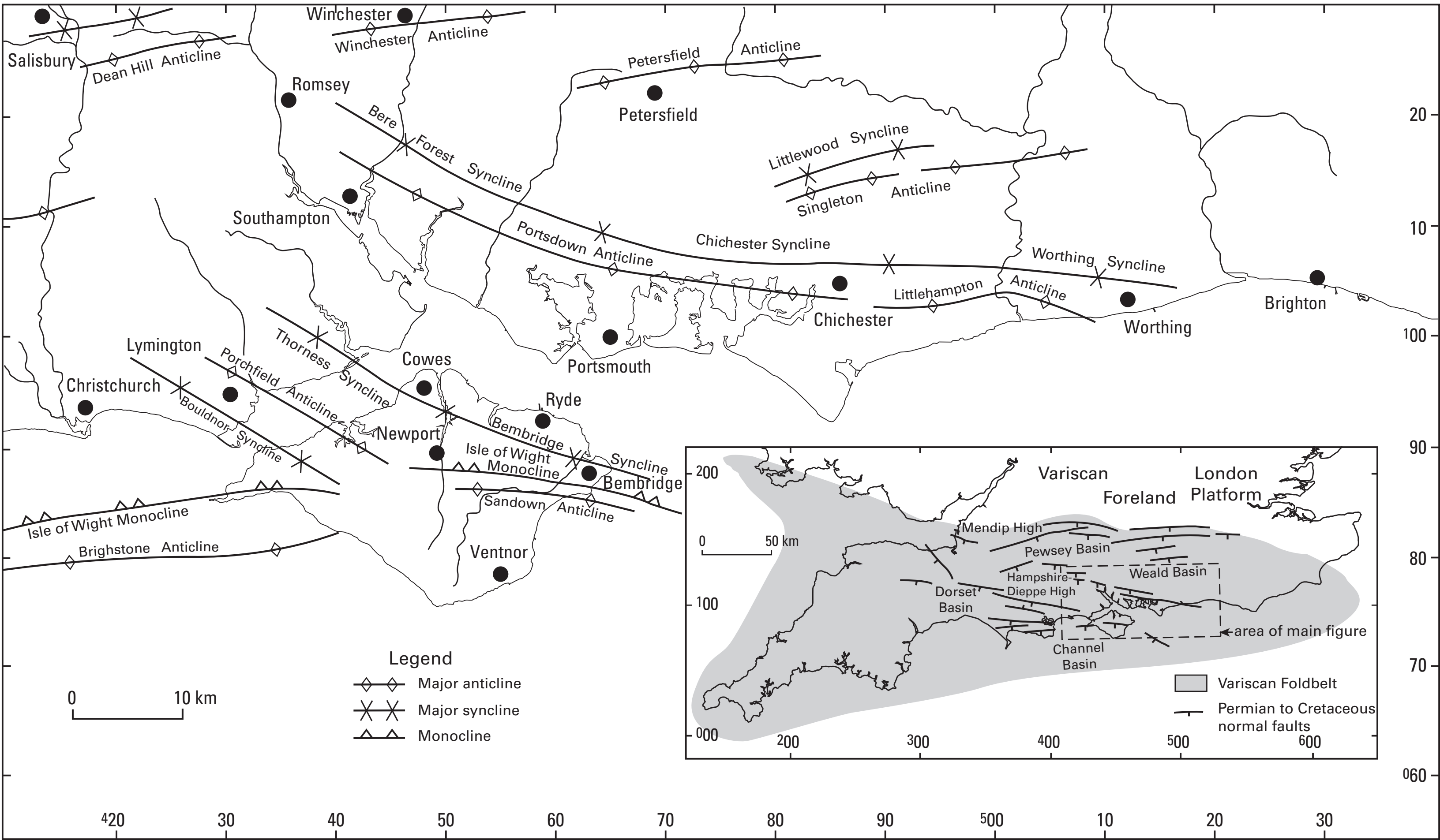
GEOLOGICAL MAP OF THE ISLE OF WIGHT.



GEOLOGICAL MAP OF THE ISLE OF WIGHT.

Figure

Figure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Romsey
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Petersfield
Bere Forest Syncline
Southampton
Littlewood Syncline
Singleton Anticline
Portsdown Anticline
Chichester Syncline
Worthing Syncline
Littlehampton Anticline
Chichester
Worthing
Brighton
Portsmouth
Lymington
Porchfield Anticline
Thorness Syncline
Cowes
Christchurch
Bouldnor Syncline
Newport
Ryde
Bembridge Syncline
Isle of Wight Monocline
Bembridge
Sandown Anticline
Isle of Wight Monocline
Brighstone Anticline
Ventnor
Legend
Major anticline
Major syncline
Monocline
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London Platform
Mendip High
Pewsey Basin
Weald Basin
Hampshire-Dieppe High
Dorset Basin
Channel Basin
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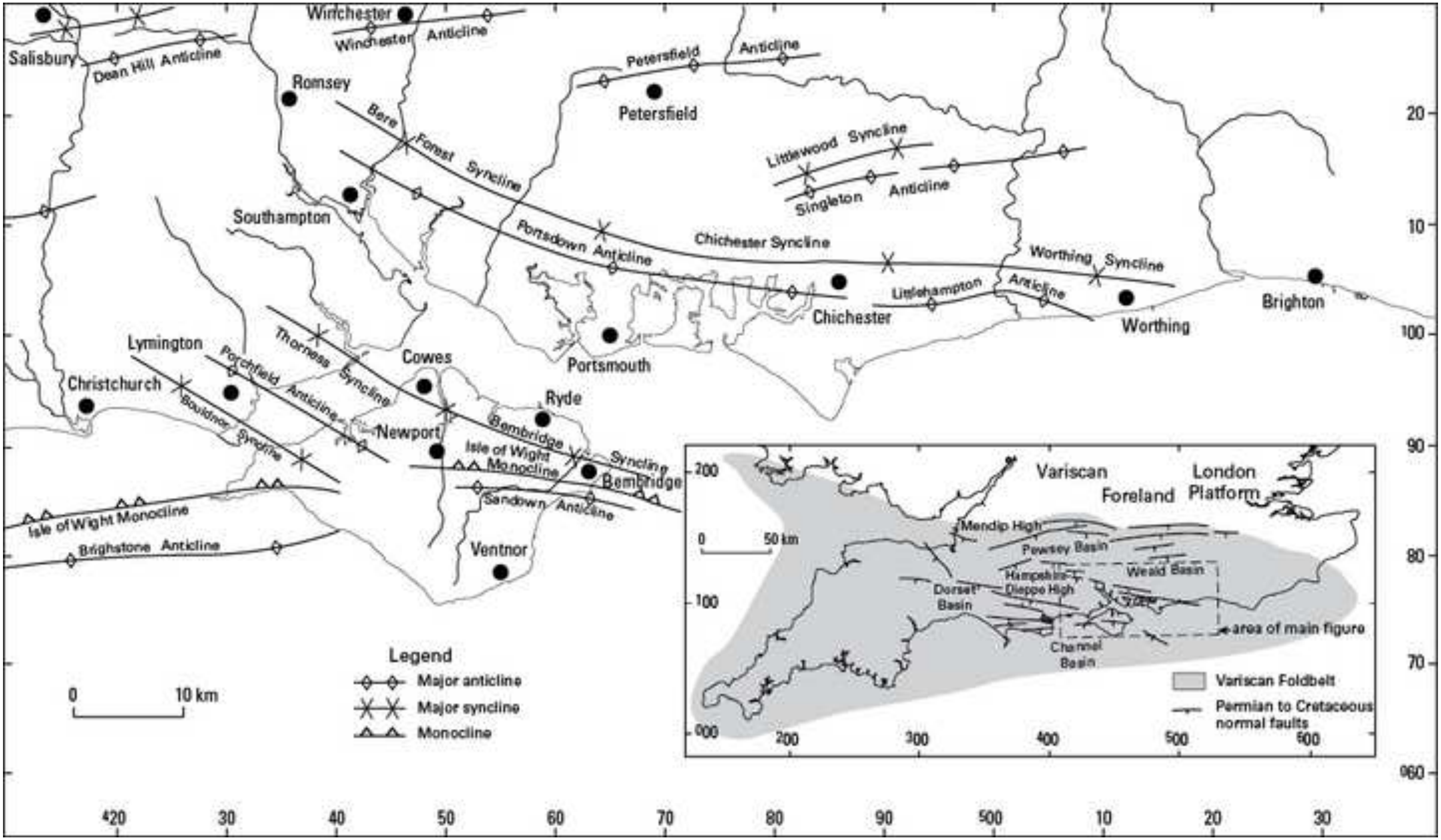
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Portsdown Anticline
Chichester Syncline
Worthing Syncline
Littlehampton Anticline
Chichester
Worthing
Brighton
Portsmouth
Lymington
Christchurch
Porchfield Anticline
Thorness Syncline
Cowes
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Bouldnor Syncline
Newport
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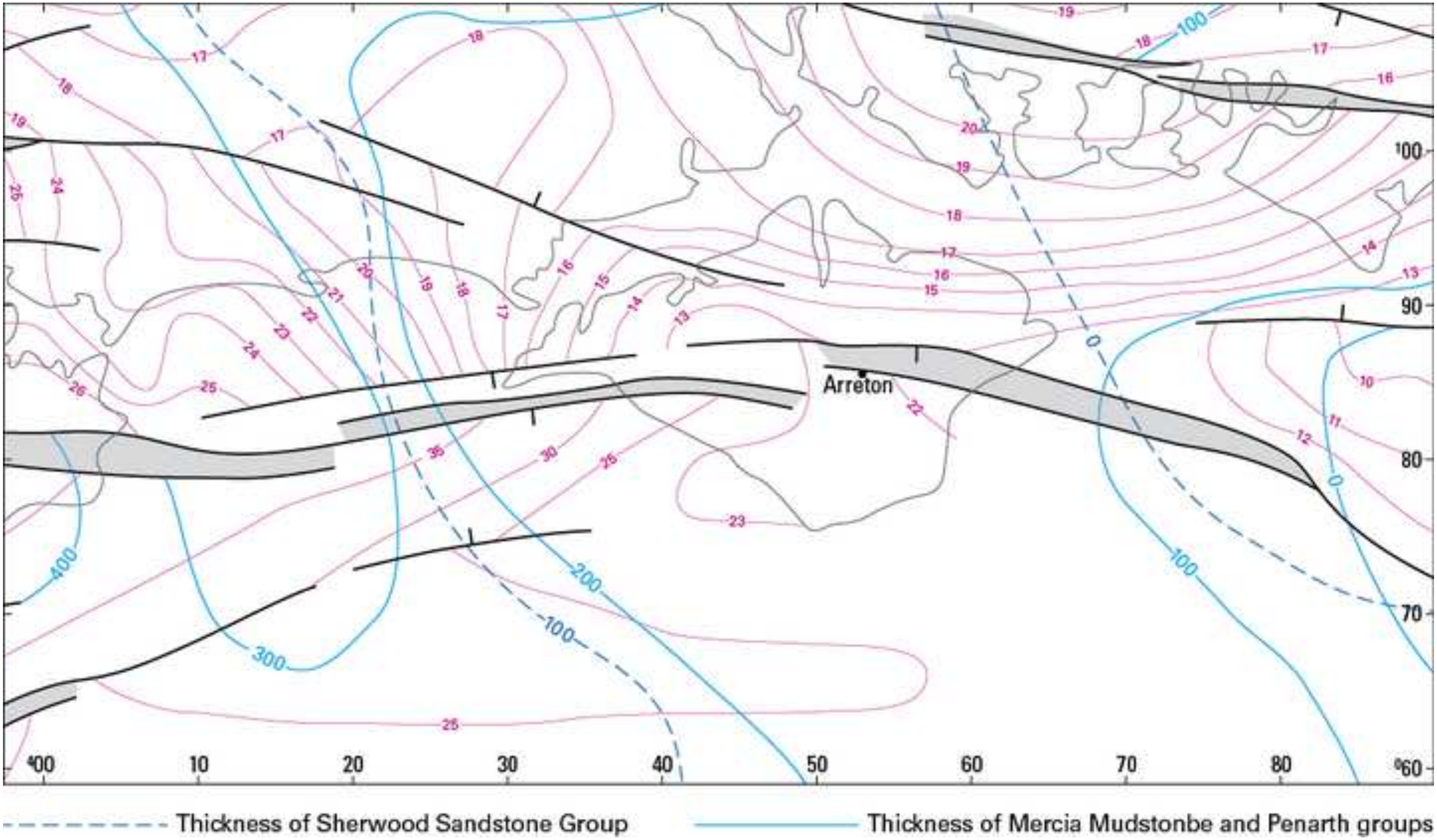
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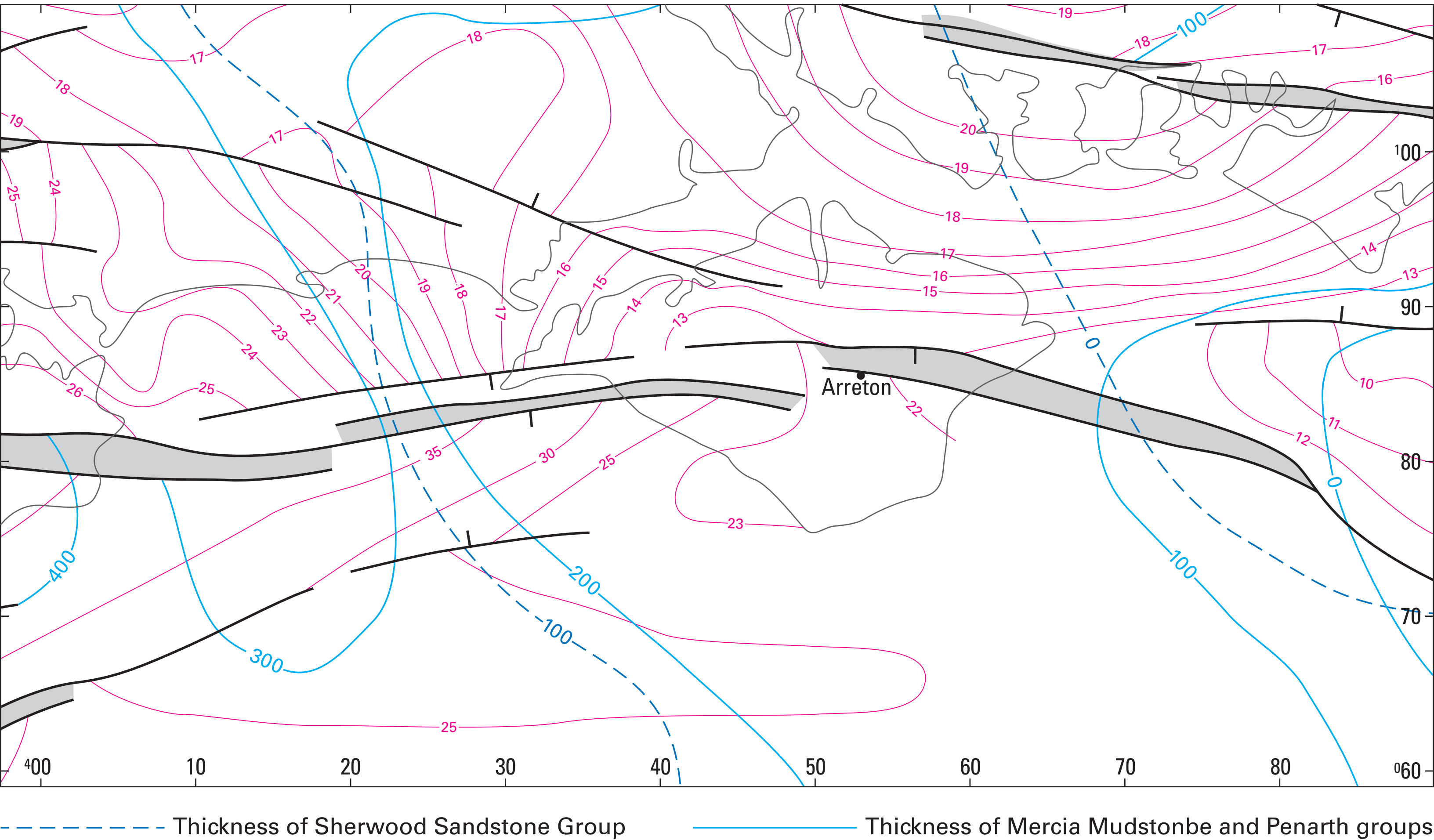
Thickness of Sherwood Sandstone Group
Thickness of Mercia Mudstonbe and Penarth groups

Figure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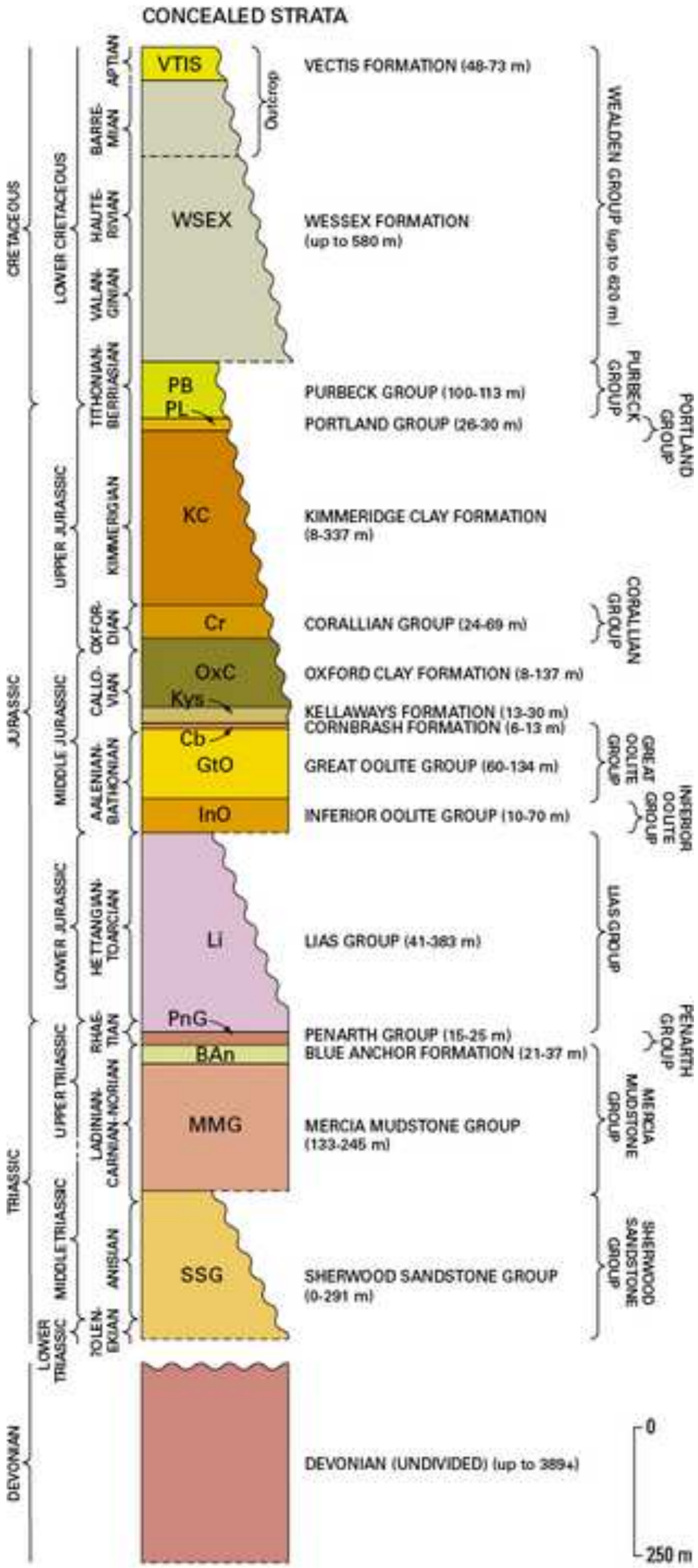
Thickness of Sherwood Sandstone Group
Thickness of Mercia Mudstonbe and Penarth groups


CONCEALED STRATA
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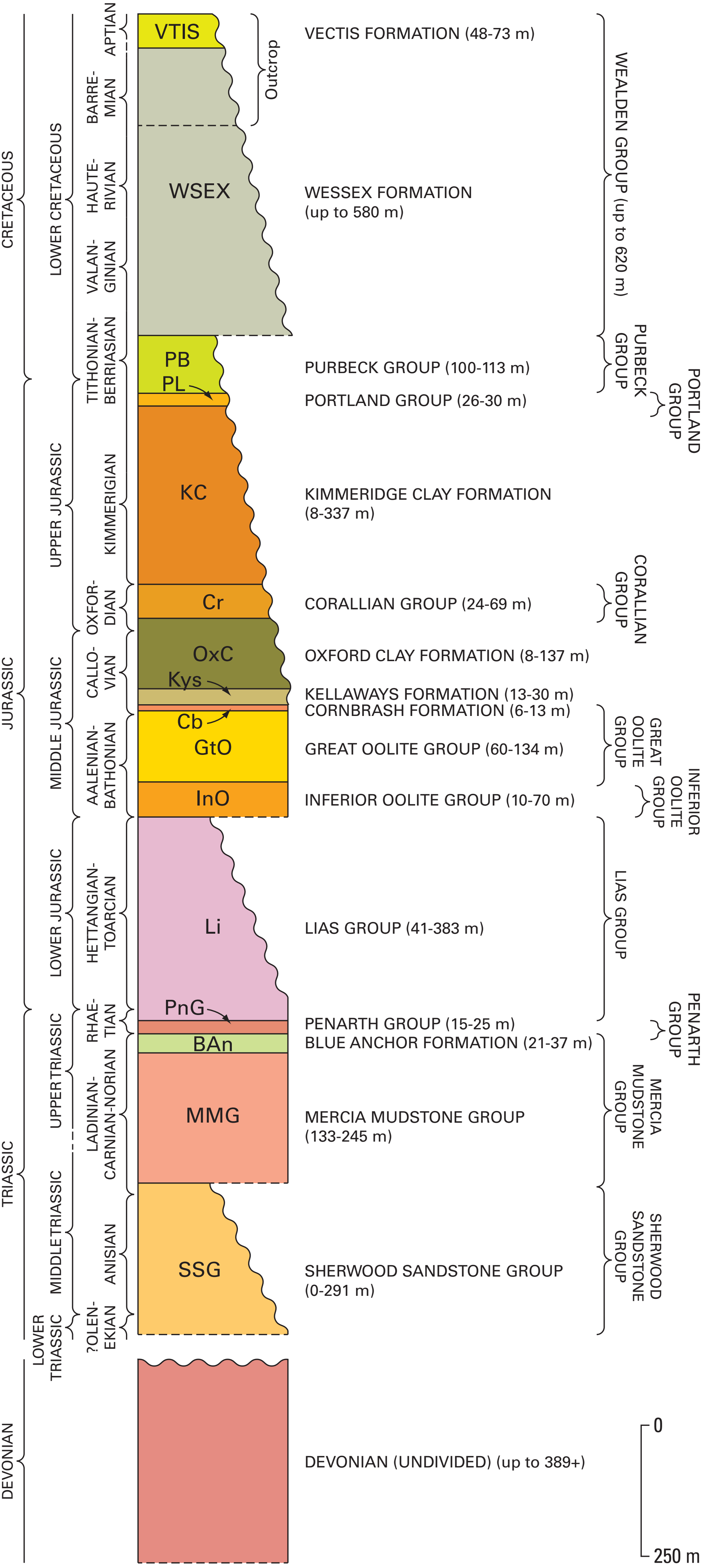
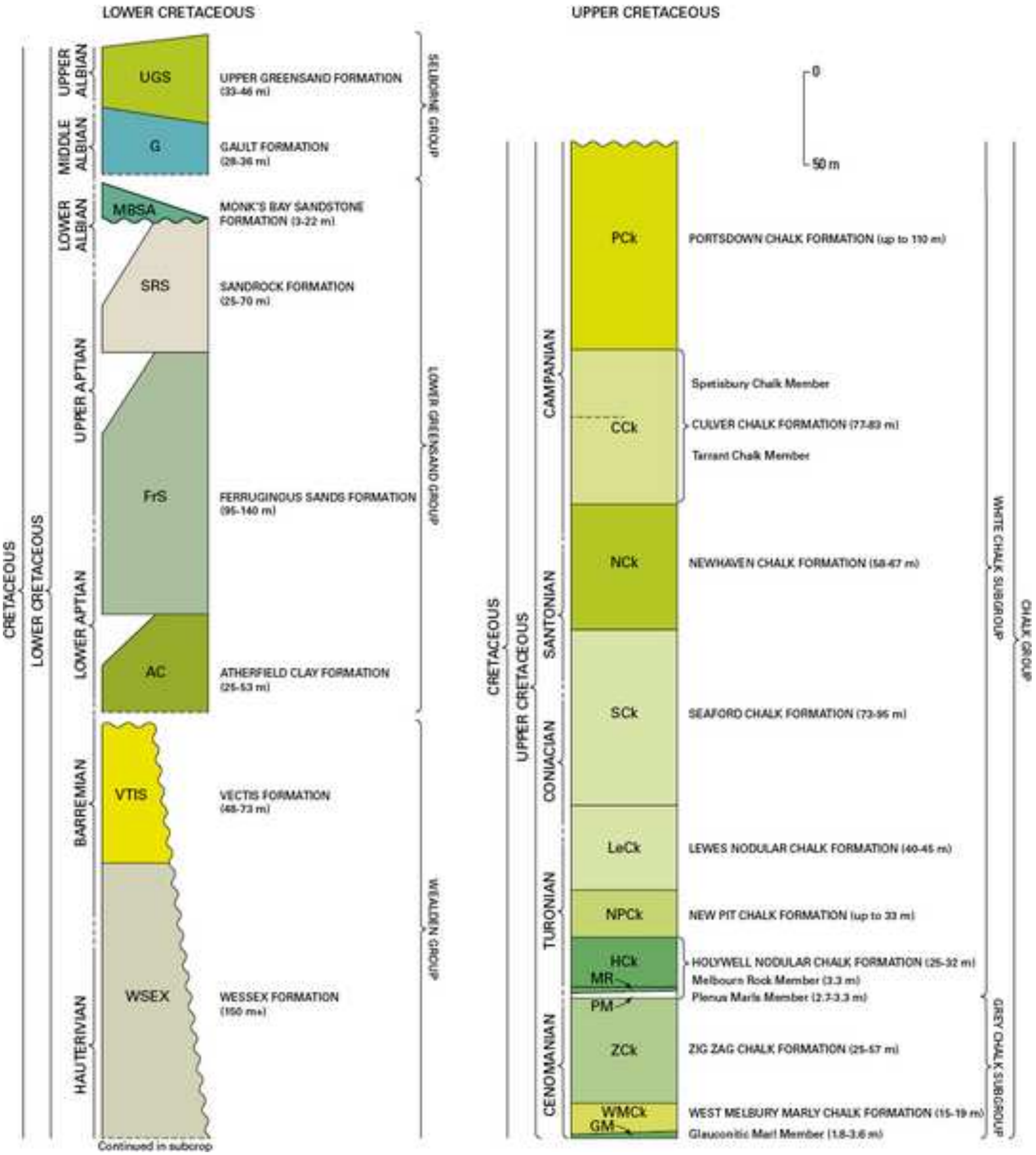
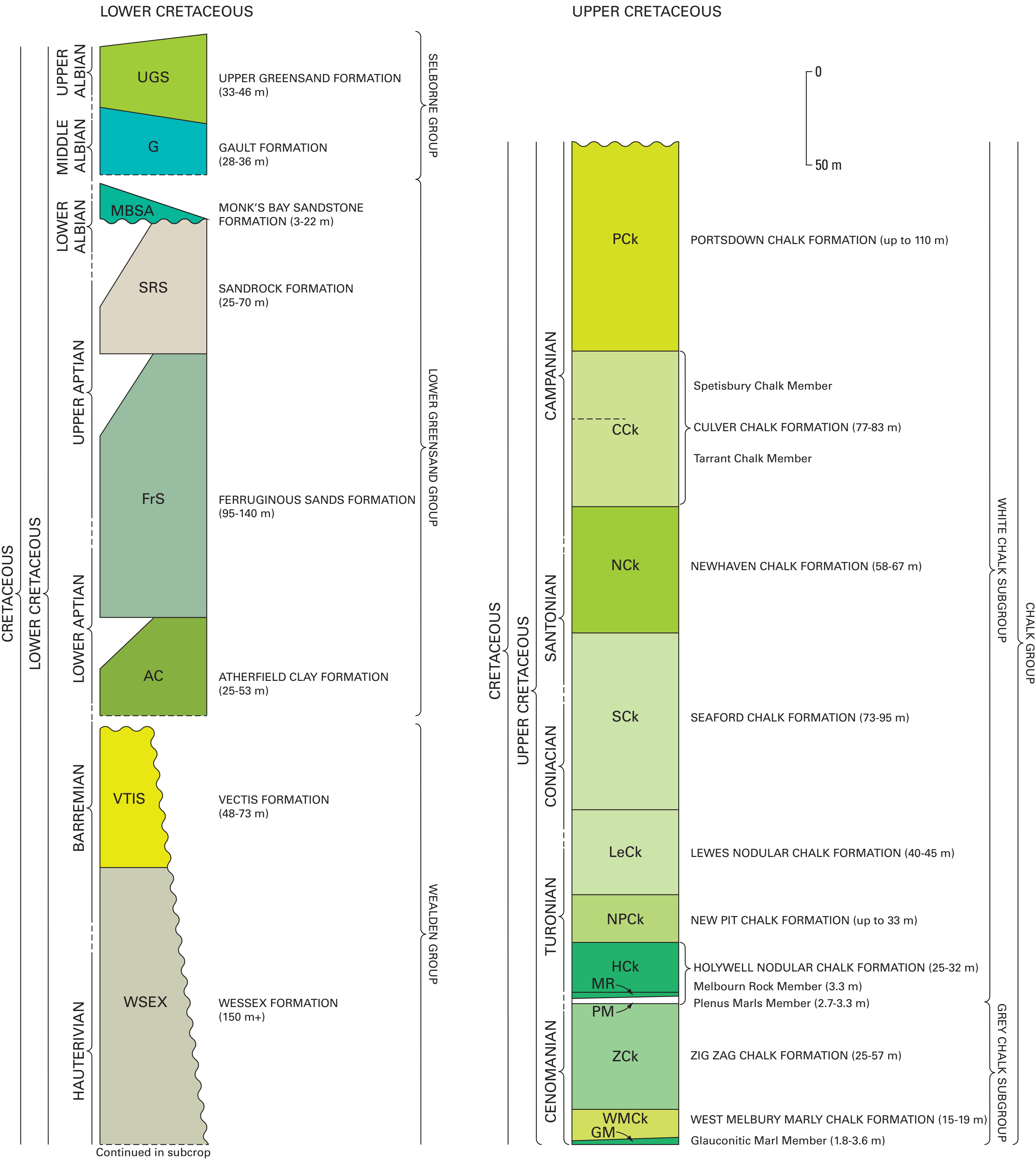
TRIASSIC
DEVONIAN
LOWER CRETACEOUS
UPPER JURASSIC
MIDDLE JURASSIC
LOWER JURASSIC
UPPER TRIASSIC
MIDDLE TRIASSIC
LOWER TRIASSIC
APTIAN
BARRE-MIAN
HAUTE-RIVIAN
VALAN-GINIAN
TITHONIAN-BERRIASIAN
KIMMERIGIAN
OXFOR-DIAN
CALLO-VIAN
AALENIAN-BATHONIAN
HETTANGIAN-TOARCIAN
RHAE-TIAN
LADINIAN-CARNIAN-NORIAN
ANISIAN
?OLEN-EKIAN
VTIS
Outcrop
WSEX
PB
PL
KC
Cr
OxC
Kys
Cb
GtO
InO
Li
PnG
BAn
MMG
SSG
VECTIS FORMATION (48-73 m)
WESSEX FORMATION (up to 580 m)
PURBECK GROUP (100-113 m)
PORTLAND GROUP (26-30 m)
KIMMERIDGE CLAY FORMATION (8-337 m)
CORALLIAN GROUP (24-69 m)
OXFORD CLAY FORMATION (8-137 m)
KELLAWAYS FORMATION (13-30 m)
CORNBRASH FORMATION (6-13 m)
GREAT OOLITE GROUP (60-134 m)
INFERIOR OOLITE GROUP (10-70 m)
LIAS GROUP (41-383 m)
PENARTH GROUP (15-25 m)
BLUE ANCHOR FORMATION (21-37 m)
MERCIA MUDSTONE GROUP (133-245 m)
SHERWOOD SANDSTONE GROUP (0-291 m)
DEVONIAN (UNDIVIDED) (up to 389+)
WEALDEN GROUP (up to 620 m)
PURBECK GROUP
PORTLAND GROUP
CORALLIAN GROUP
GREAT OOLITE GROUP
INFERIOR OOLITE GROUP
LIAS GROUP
PENARTH GROUP
MERCIA MUDSTONE GROUP
SHERWOOD SANDSTONE GROUP
0
250 m

Figure

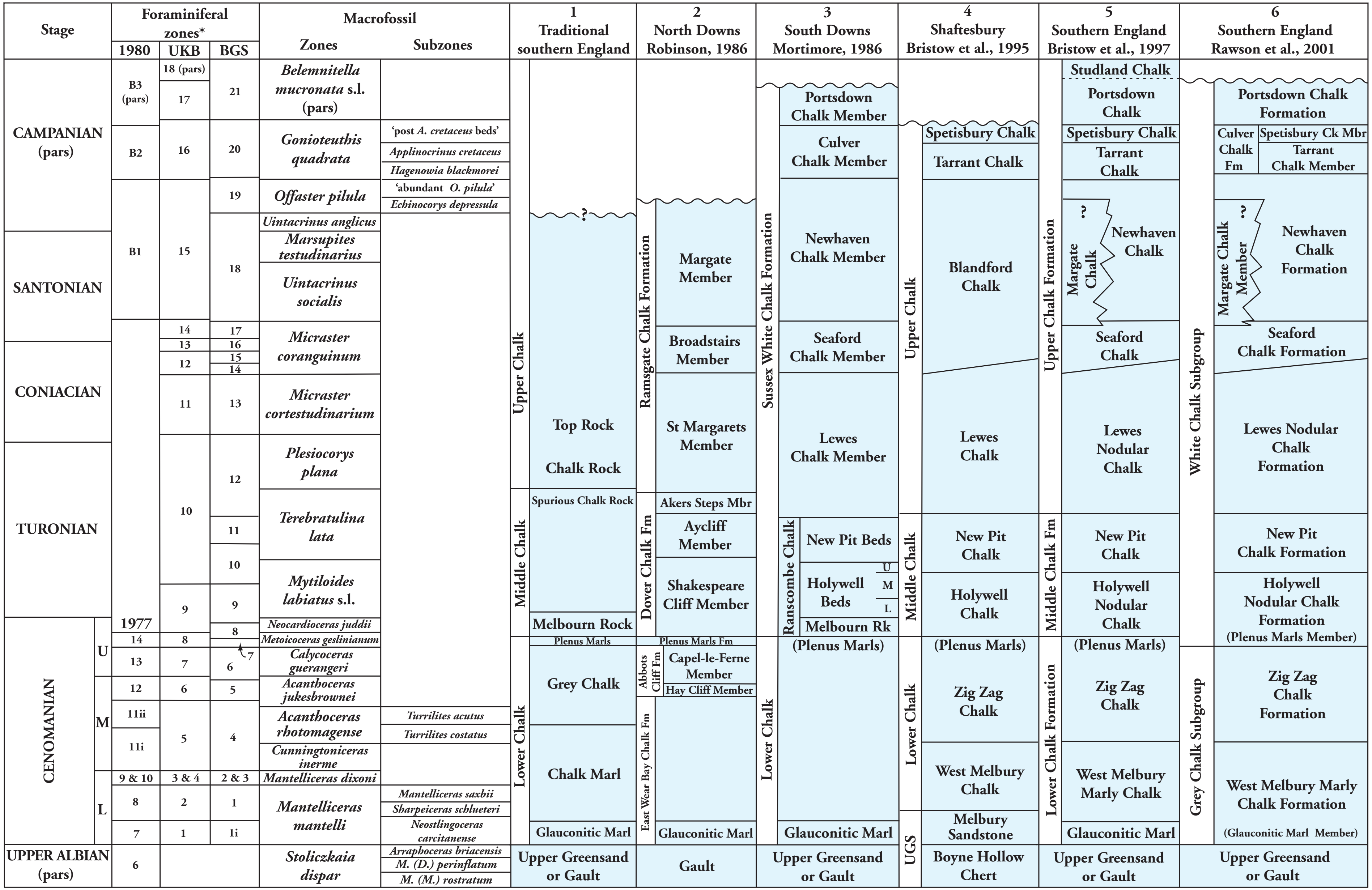

CONCEALED STRATA


LOWER CRETACEOUS
UPPER CRETACEOUS
CRETACEOUS
LOWER CRETACEOUS
UPPER ALBIAN
MIDDLE ALBIAN
LOWER ALBIAN
UPPER APTIAN
LOWER APTIAN
BARREMIAN
HAUTERIVIAN
UGS
G
MBSA
SRS
FrS
AC
VTIS
WSEX
UPPER GREENSAND FORMATION (33-46 m)
GAULT FORMATION (28-36 m)
MONK'S BAY SANDSTONE FORMATION (3-22 m)
SANDROCK FORMATION (25-70 m)
FERRUGINOUS SANDS FORMATION (95-140 m)
ATHERFIELD CLAY FORMATION (25-53 m)
VECTIS FORMATION (48-73 m)
WESSEX FORMATION (150 m+)
SELBORNE GROUP
LOWER GREENSAND GROUP
WEALDEN GROUP
Continued in subcrop
0
50 m
CRETACEOUS
UPPER CRETACEOUS
CAMPANIAN
SANTONIAN
CONIACIAN
TURONIAN
CENOMANIAN
PCk
CCk
NCk
SCk
LeCk
NPCk
HCk
MR
PM
ZCk
WMCk
GM
PORTSDOWN CHALK FORMATION (up to 110 m)
Spetisbury Chalk Member
CULVER CHALK FORMATION (77-83 m)
Tarrant Chalk Member
NEWHAVEN CHALK FORMATION (58-67 m)
SEAFORD CHALK FORMATION (73-96 m)
LEWES NODULAR CHALK FORMATION (40-45 m)
NEW PIT CHALK FORMATION (up to 33 m)
HOLYWELL NODULAR CHALK FORMATION (25-32 m)
Melbourn Rock Member (3.3 m)
Plenus Marls Member (2.7-3.3 m)
ZIG ZAG CHALK FORMATION (25-57 m)
WEST MELBURY MARLY CHALK FORMATION (15-19 m)
Glauconitic Marl Member (1.8-3.6 m)
WHITE CHALK SUBGROUP
GREY CHALK SUBGROUP
CHALK GROUP

Figure


LOWER CRETACEOUS
UPPER CRETACEOUS
CRETACEOUS
LOWER CRETACEOUS
UPPER ALBIAN
MIDDLE ALBIAN
LOWER ALBIAN
UPPER APTIAN
LOWER APTIAN
BARREMIAN
HAUTERIVIAN
UGS
UPPER GREENSAND FORMATION (33-46 m)
G
GAULT FORMATION (28-36 m)
MBSA
MONK'S BAY SANDSTONE FORMATION (3-22 m)
SRS
SANDROCK FORMATION (25-70 m)
FrS
FERRUGINOUS SANDS FORMATION (95-140 m)
AC
ATHERFIELD CLAY FORMATION (25-53 m)
VTIS
VECTIS FORMATION (48-73 m)
WSEX
WESSEX FORMATION (150 m+)
Continued in subcrop
SELBORNE GROUP
LOWER GREENSAND GROUP
WEALDEN GROUP
0
50 m
CRETACEOUS
UPPER CRETACEOUS
CAMPANIAN
SANTONIAN
CONIACIAN
TURONIAN
CENOMANIAN
PCk
PORTSDOWN CHALK FORMATION (up to 110 m)
CCk
Spetisbury Chalk Member
CULVER CHALK FORMATION (77-83 m)
Tarrant Chalk Member
NCk
NEWHAVEN CHALK FORMATION (58-67 m)
SCk
SEAFORD CHALK FORMATION (73-95 m)
LeCk
LEWES NODULAR CHALK FORMATION (40-45 m)
NPCk
NEW PIT CHALK FORMATION (up to 33 m)
HCk
MR
HOLYWELL NODULAR CHALK FORMATION (25-32 m)
Melbourn Rock Member (3.3 m)
PM
Plenus Marls Member (2.7-3.3 m)
ZCk
ZIG ZAG CHALK FORMATION (25-57 m)
WMCk
GM
WEST MELBURY MARLY CHALK FORMATION (15-19 m)
Glauconitic Marl Member (1.8-3.6 m)
WHITE CHALK SUBGROUP
GREY CHALK SUBGROUP
CHALK GROUP

Figure

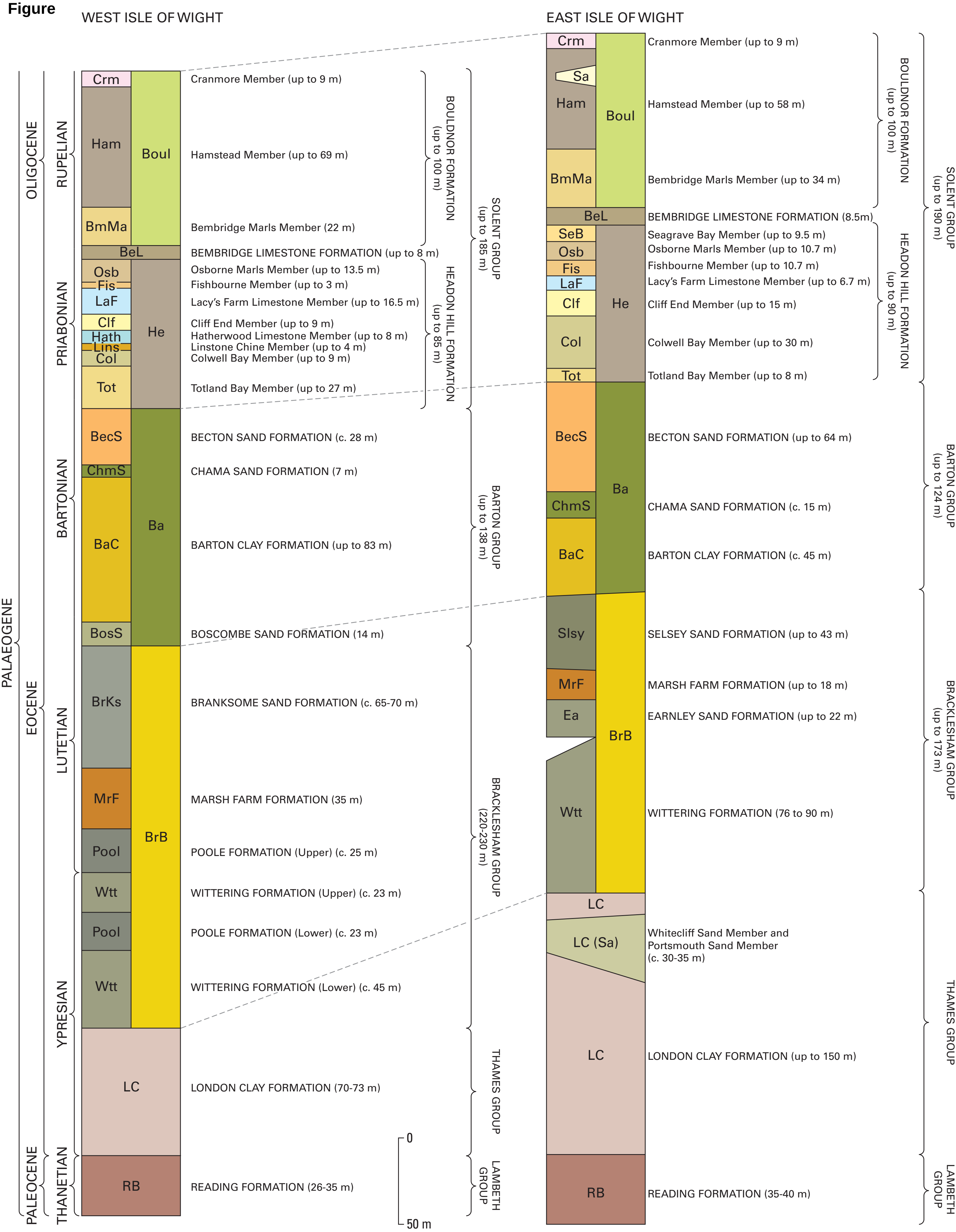


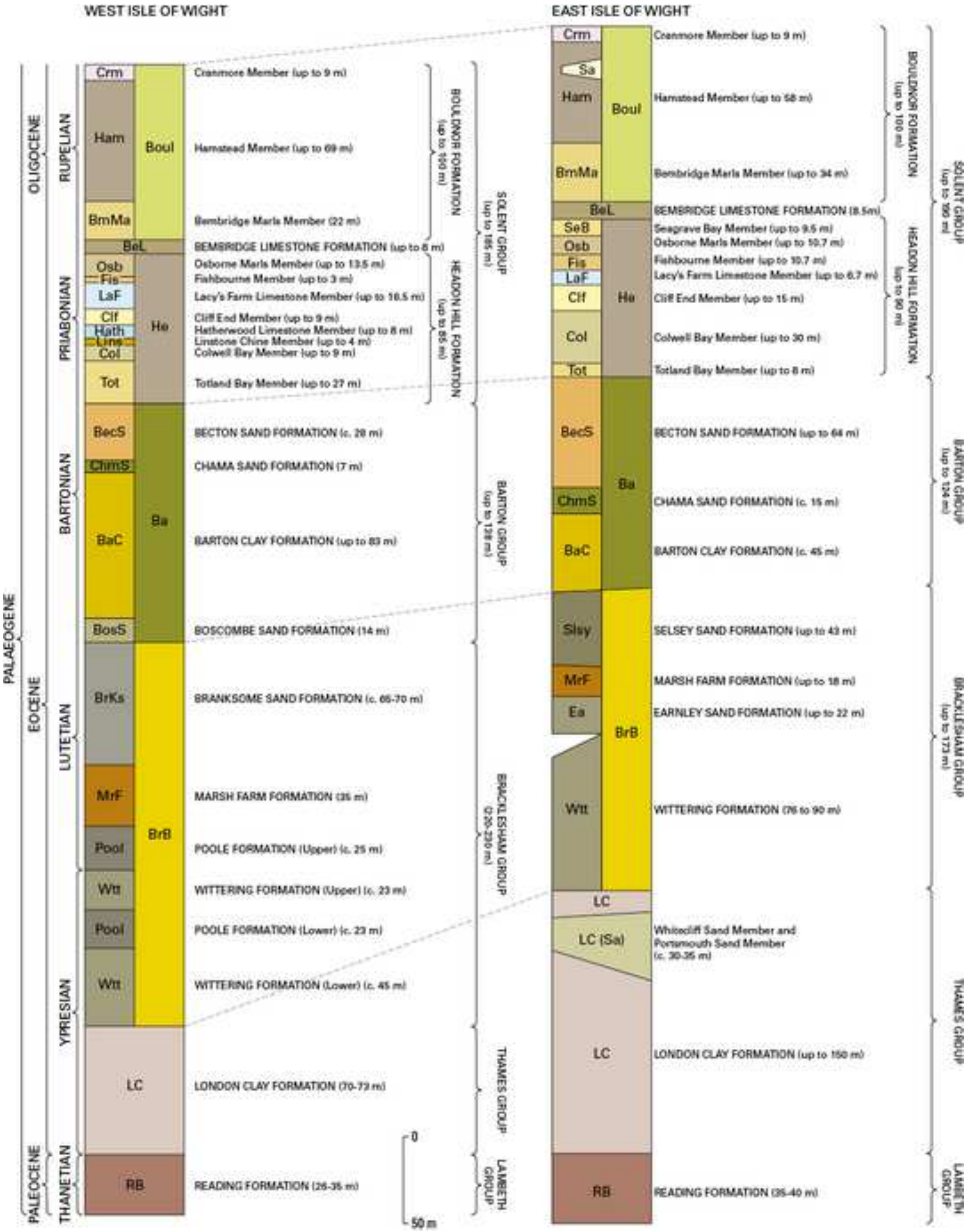
#Traditional Chalk subdivision after Jukes-Browne and Hill (1903, 1904, for example). UGS = Upper Greensand; s.l. = *sensu lato.*
*Foraminiferal zones after Carter and Hart, 1977; Swiecicki, 1980; Hart et al., 1989 (UKB zones) and Wilkinson, 2000a (BGS zones).

Not to scale

Upper Cretaceous Report Nov 04	Size Land 262 x 167 mm
Fig 03.ai - 1st Proof	Adapted by R.J.Demaine
Fig 03.ai - 2nd Proof	R.J.Demaine
Fig 03.ai - 3rd Proof	R.J.Demaine

Figure


WEST ISLE OF WIGHT
EAST ISLE OF WIGHT
PALAEOGENE
OLIGOCENE
EOCENE
PALEOCENE
RUPELIAN
PRIABONIAN
BARTONIAN
LUTETIAN
YPRESIAN
THANETIAN
Crm
Ham
BmMa
Boul
BeL
Osb
Fis
LaF
Clf
Hath
Lins
Col
Tot
He
BecS
ChmS
BaC
BosS
Ba
BrKs
MrF
Pool
Wtt
Pool
Wtt
BrB
LC
RB
Cranmore Member (up to 9 m)
Hamstead Member (up to 69 m)
Bembridge Marls Member (22 m)
BEMBRIDGE LIMESTONE FORMATION (up to 8 m)
Osborne Marls Member (up to 13.5 m)
Fishbourne Member (up to 3 m)
Lacy's Farm Limestone Member (up to 16.5 m)
Cliff End Member (up to 9 m)
Hatherwood Limestone Member (up to 8 m)
Linstone Chine Member (up to 4 m)
Colwell Bay Member (up to 9 m)
Totland Bay Member (up to 27 m)
BECTON SAND FORMATION (c. 28 m)
CHAMA SAND FORMATION (7 m)
BARTON CLAY FORMATION (up to 83 m)
BOSCOMBE SAND FORMATION (14 m)
BRANKSOME SAND FORMATION (c. 65-70 m)
MARSH FARM FORMATION (35 m)
POOLE FORMATION (Upper) (c. 25 m)
WITTERING FORMATION (Upper) (c. 23 m)
POOLE FORMATION (Lower) (c. 23 m)
WITTERING FORMATION (Lower) (c. 45 m)
LONDON CLAY FORMATION (70-73 m)
READING FORMATION (26-35 m)
BOULDNOR FORMATION (up to 100 m)
HEADON HILL FORMATION (up to 85 m)
SOLENT GROUP (up to 185 m)
BARTON GROUP (up to 138 m)
BRACKLESHAM GROUP (220-230 m)
THAMES GROUP
LAMBETH GROUP
0
50 m
Crm
Sa
Ham
Boul
BmMa
BeL
SeB
Osb
Fis
LaF
Clf
Col
Tot
He
BecS
ChmS
BaC
Ba
Slsy
MrF
Ea
Wtt
BrB
LC
LC (Sa)
LC
RB
Cranmore Member (up to 9 m)
Hamstead Member (up to 58 m)
Bembridge Marls Member (up to 34 m)
BEMBRIDGE LIMESTONE FORMATION (8.5m)
Seagrave Bay Member (up to 9.5 m)
Osborne Marls Member (up to 10.7 m)
Fishbourne Member (up to 10.7 m)
Lacy's Farm Limestone Member (up to 6.7 m)
Cliff End Member (up to 15 m)
Colwell Bay Member (up to 30 m)
Totland Bay Member (up to 8 m)
BECTON SAND FORMATION (up to 64 m)
CHAMA SAND FORMATION (c. 15 m)
BARTON CLAY FORMATION (c. 45 m)
SELSEY SAND FORMATION (up to 43 m)
MARSH FARM FORMATION (up to 18 m)
EARNLEY SAND FORMATION (up to 22 m)
WITTERING FORMATION (76 to 90 m)
Whitecliff Sand Member and Portsmouth Sand Member (c. 30-35 m)
LONDON CLAY FORMATION (up to 150 m)
READING FORMATION (35-40 m)
BOULDNOR FORMATION (up to 100 m)
HEADON HILL FORMATION (up to 90 m)
SOLENT GROUP (up to 190 m)
BARTON GROUP (up to 124 m)
BRACKLESHAM GROUP (up to 173 m)
THAMES GROUP
LAMBETH GROUP


WEST ISLE OF WIGHT
EAST ISLE OF WIGHT
PALAEOGENE
OLIGOCENE
EOCENE
PALEOCENE
RUPELIAN
PRIABONIAN
BARTONIAN
LUTETIAN
YPRESIAN
THANETIAN
Crm
Ham
BmMa
Boul
BeL
Osb
Fis
LaF
Clf
Hath
Lins
Col
Tot
He
BecS
ChmS
BaC
Ba
BosS
BrKs
MrF
Pool
Wtt
Pool
Wtt
BrB
LC
RB
Cranmore Member (up to 9 m)
Hamstead Member (up to 69 m)
Bembridge Marls Member (22 m)
BEMBRIDGE LIMESTONE FORMATION (up to 8 m)
Osborne Marls Member (up to 13.5 m)
Fishbourne Member (up to 3 m)
Lacy's Farm Limestone Member (up to 18.5 m)
Cliff End Member (up to 9 m)
Hatherwood Limestone Member (up to 8 m)
Linstone Chine Member (up to 4 m)
Colwell Bay Member (up to 9 m)
Totland Bay Member (up to 27 m)
BECTON SAND FORMATION (c. 28 m)
CHAMA SAND FORMATION (7 m)
BARTON CLAY FORMATION (up to 83 m)
BOSCOMBE SAND FORMATION (14 m)
BRANKSOME SAND FORMATION (c. 65-70 m)
MARSH FARM FORMATION (35 m)
POOLE FORMATION (Upper) (c. 25 m)
WITTERING FORMATION (Upper) (c. 23 m)
POOLE FORMATION (Lower) (c. 23 m)
WITTERING FORMATION (Lower) (c. 45 m)
LONDON CLAY FORMATION (70-73 m)
READING FORMATION (26-35 m)
BOULDNOR FORMATION (up to 100 m)
HEADON HILL FORMATION (up to 85 m)
SOLENT GROUP (up to 185 m)
BARTON GROUP (up to 128 m)
BRACKLESHAM GROUP (120-230 m)
THAMES GROUP
LAMBETH GROUP
0
50 m
Crm
Sa
Ham
Boul
BmMa
BeL
SeB
Osb
Fis
LaF
Clf
He
Col
Tot
BecS
Ba
ChmS
BaC
Slsy
MrF
Ea
BrB
Wtt
LC
LC (Sa)
LC
RB
Cranmore Member (up to 9 m)
Hamstead Member (up to 58 m)
Bembridge Marls Member (up to 34 m)
BEMBRIDGE LIMESTONE FORMATION (8.5m)
Seagrave Bay Member (up to 9.5 m)
Osborne Marls Member (up to 10.7 m)
Fishbourne Member (up to 10.7 m)
Lacy's Farm Limestone Member (up to 6.7 m)
Cliff End Member (up to 15 m)
Colwell Bay Member (up to 30 m)
Totland Bay Member (up to 8 m)
BECTON SAND FORMATION (up to 64 m)
CHAMA SAND FORMATION (c. 15 m)
BARTON CLAY FORMATION (c. 45 m)
SELSEY SAND FORMATION (up to 43 m)
MARSH FARM FORMATION (up to 18 m)
EARNLEY SAND FORMATION (up to 22 m)
WITTERING FORMATION (76 to 90 m)
Whitecliff Sand Member and
Portsmouth Sand Member
(c. 30-35 m)
LONDON CLAY FORMATION (up to 150 m)
READING FORMATION (35-40 m)
BOULDNOR FORMATION (up to 100 m)
HEADON HILL FORMATION (up to 90 m)
SOLENT GROUP (up to 190 m)
BARTON GROUP (up to 124 m)
BRACKLESHAM GROUP (up to 173 m)
THAMES GROUP
LAMBETH GROUP

Figure

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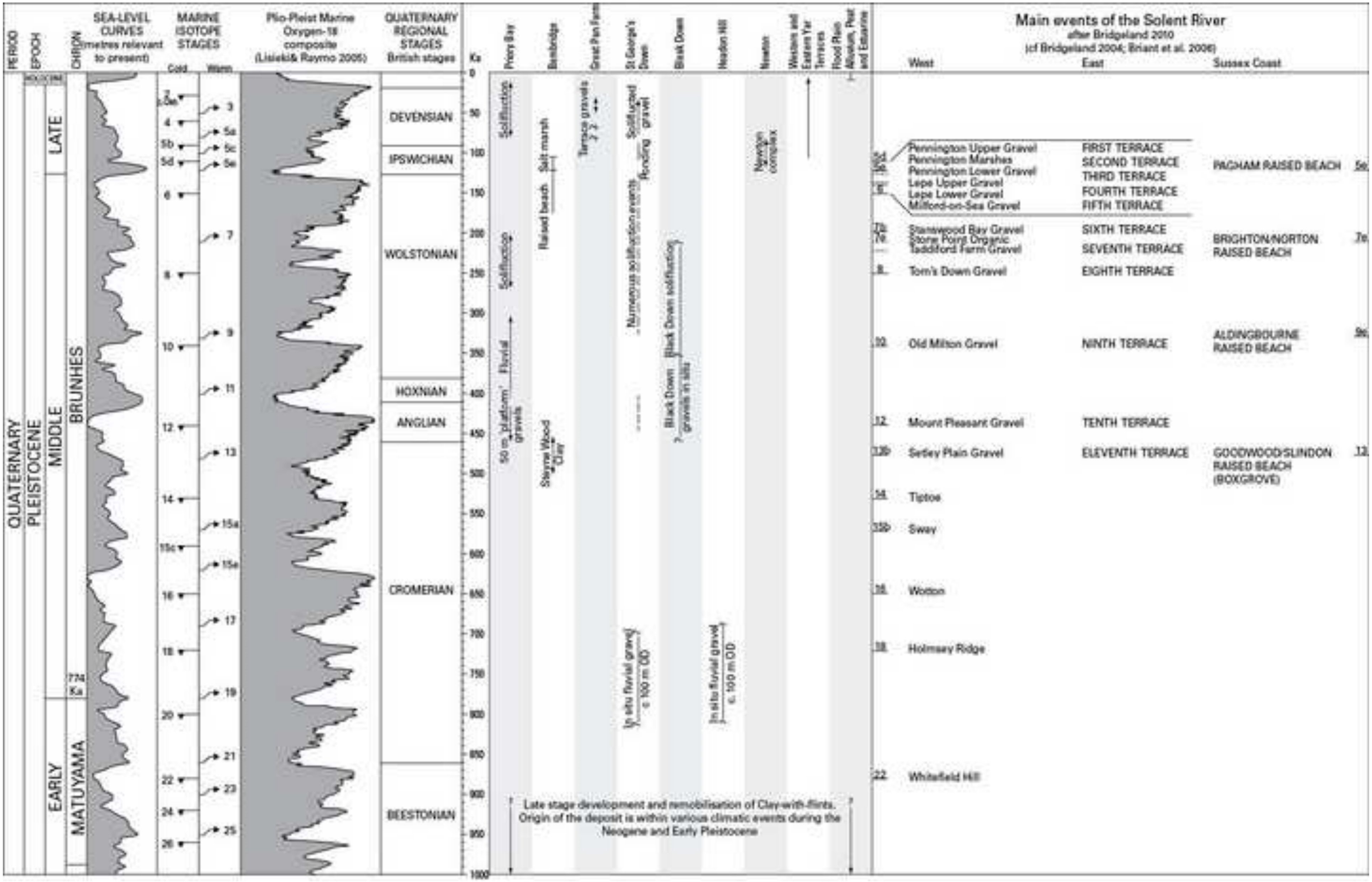
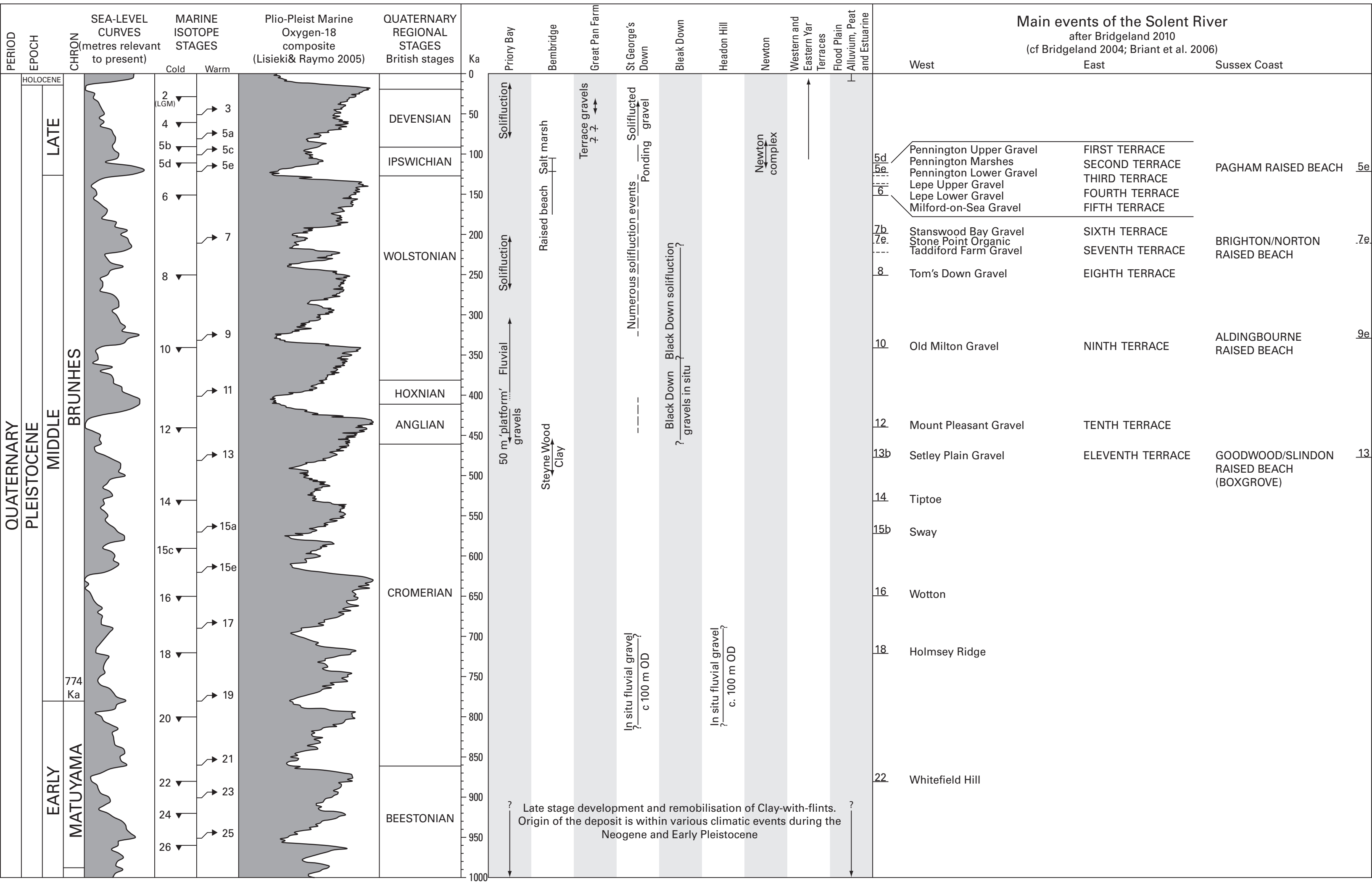
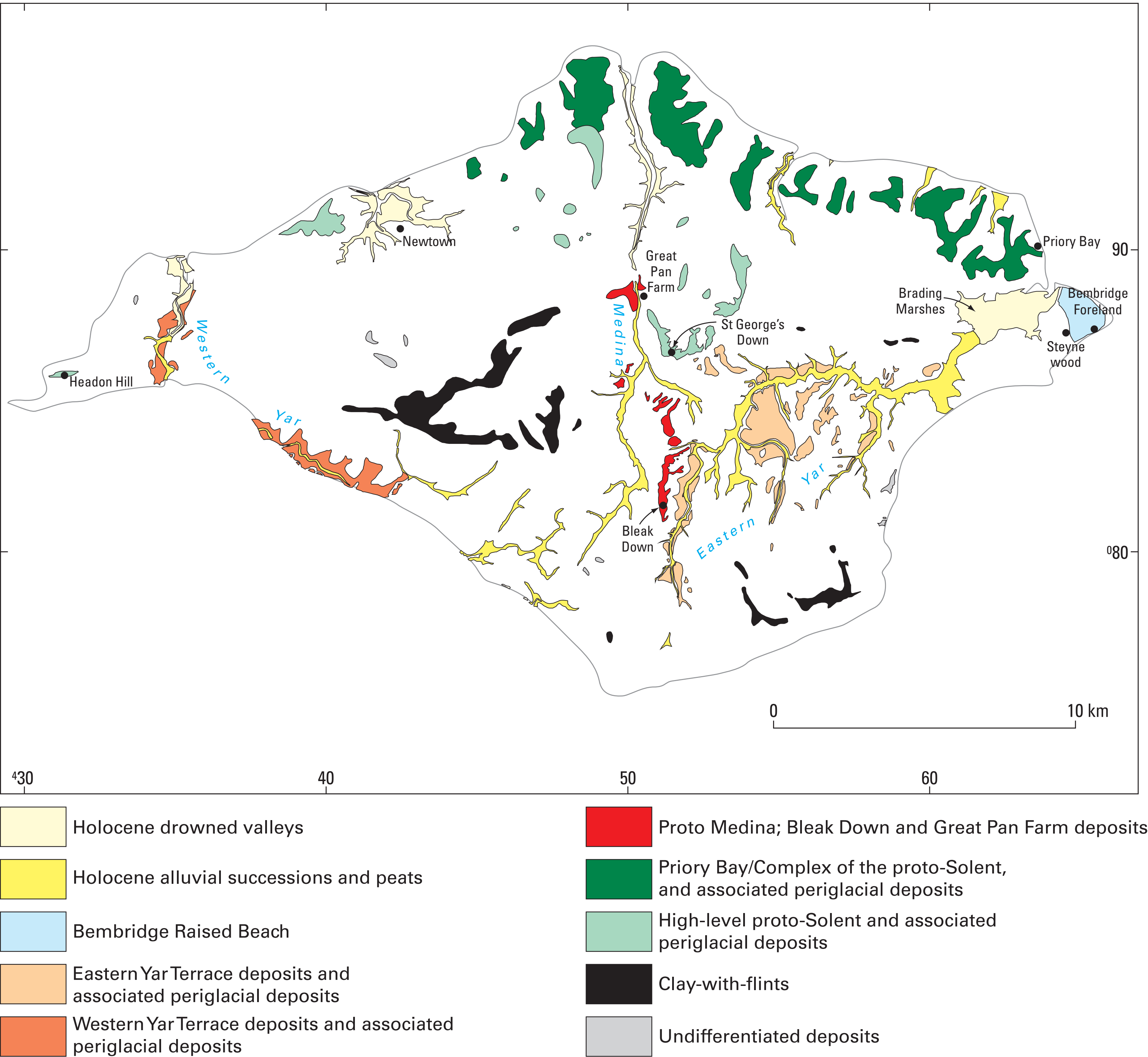
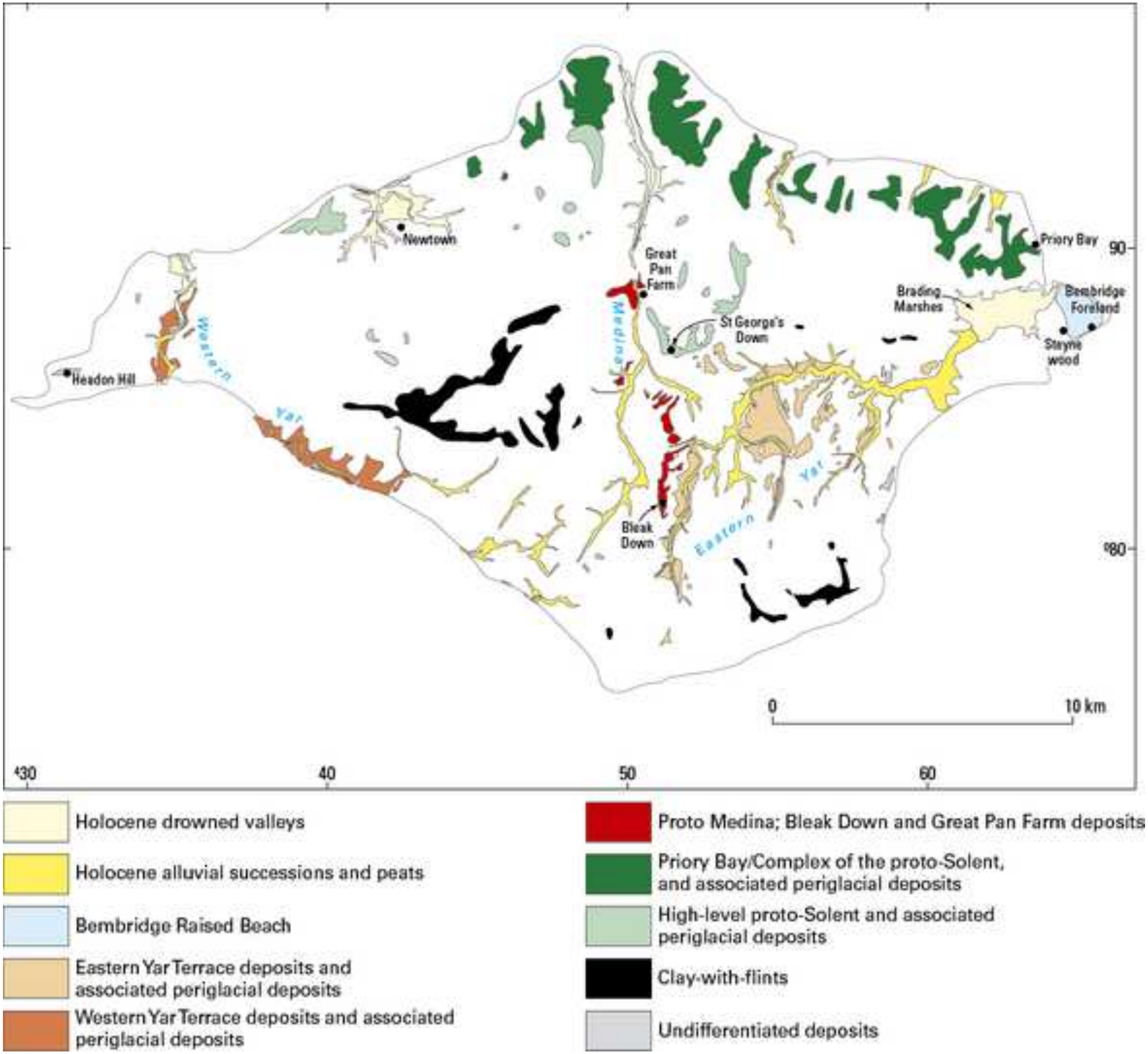


Figure


PERIOD
EPOCH
CHRON
SEA-LEVEL CURVES (metres relevant to present)
MARINE ISOTOPE STAGES
Cold
Warm
Plio-Pleist Marine Oxygen-18 composite (Lisieki& Raymo 2005)
QUATERNARY REGIONAL STAGES British stages
Ka
Priory Bay
Bembridge
Great Pan Farm
St George's Down
Bleak Down
Headon Hill
Newton
Western and Eastern Yar Terraces
Flood Plain Alluvium, Peat and Estuarine
Main events of the Solent River
after Bridgeland 2010
(cf Bridgeland 2004; Briant et al. 2006)
West
East
Sussex Coast
QUATERNARY
PLEISTOCENE
HOLOCENE
LATE
MIDDLE
EARLY
BRUNHES
MATUYAMA
774 Ka
2 (LGM)
3
4
5a
5b
5c
5d
5e
6
7
8
9
10
11
12
13
14
15a
15c
15e
16
17
18
19
20
21
22
23
24
25
26
DEVENSIAN
IPSWICHIAN
WOLSTONIAN
HOXNIAN
ANGLIAN
CROMERIAN
BEESTONIAN
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
Solifluction
Solifluction
Fluvial
50 m 'platform' gravels
Salt marsh
Raised beach
Steyne Wood Clay
Terrace gravels
? ?
Soliflucted gravel
Ponding
Numerous solifluction events
In situ fluvial gravel c 100 m OD
Black Down solifluction
Black Down gravels in situ
In situ fluvial gravel c. 100 m OD
Newton complex
Late stage development and remobilisation of Clay-with-flints. Origin of the deposit is within various climatic events during the Neogene and Early Pleistocene
5d Pennington Upper Gravel FIRST TERRACE
5e Pennington Marshes SECOND TERRACE
Pennington Lower Gravel THIRD TERRACE
6 Lepe Upper Gravel FOURTH TERRACE
Lepe Lower Gravel
Milford-on-Sea Gravel FIFTH TERRACE
PAGHAM RAISED BEACH 5e
7b Stanswood Bay Gravel SIXTH TERRACE
7e Stone Point Organic
Taddiford Farm Gravel SEVENTH TERRACE
BRIGHTON/NORTON RAISED BEACH 7e
8 Tom's Down Gravel EIGHTH TERRACE
10 Old Milton Gravel NINTH TERRACE
ALDINGBOURNE RAISED BEACH 9e
12 Mount Pleasant Gravel TENTH TERRACE
13b Setley Plain Gravel ELEVENTH TERRACE
GOODWOOD/SLINDON RAISED BEACH (BOXGROVE) 13
14 Tiptoe
15b Sway
16 Wotton
18 Holmsey Ridge
22 Whitefield Hill

Figure


Newtown
Headon Hill
Western Yar
Great Pan Farm
Medina
St George's Down
Priory Bay
Brading Marshes
Bembridge Foreland
Steyne wood
Bleak Down
Eastern Yar
0
10 km
430
40
50
60
90
080
Holocene drowned valleys
Holocene alluvial successions and peats
Bembridge Raised Beach
Eastern Yar Terrace deposits and associated periglacial deposits
Western Yar Terrace deposits and associated periglacial deposits
Proto Medina; Bleak Down and Great Pan Farm deposits
Priory Bay/Complex of the proto-Solent, and associated periglacial deposits
High-level proto-Solent and associated periglacial deposits
Clay-with-flints
Undifferentiated deposits


Newtown
Priory Bay
90
Great Pan Farm
Brading Marshes
Bembridge Foreland
St George's Down
Steyne wood
Headon Hill
Western Yar
Medina
Yar
Eastern Yar
Bleak Down
80
0
10 km
430
40
50
60
Holocene drowned valleys
Holocene alluvial successions and peats
Bembridge Raised Beach
Eastern Yar Terrace deposits and associated periglacial deposits
Western Yar Terrace deposits and associated periglacial deposits
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Clay-with-flints
Undifferentiated deposits