Lavernock to St Mary's Well Bay, Glamorgan

[ST 174 676]–[ST 187 682]

Introduction

The Lavernock to St Mary's Well Bay coastal section, covering a 2 km stretch of coastline (Figure 3.1), provides the best offshore Blue Lias Formation section of South Wales, exposing about 35 m of marine Hettangian strata. The section from the Hettangian strata passes down through a continuous succession into the quasi-marine Penarth Group and the non-marine Mercia Mudstone Group of the Triassic System.

The Blue Lias Formation at this site is of typical facies, in contrast to the marginal facies of equivalent age exposed at the Pant y Slade to Witches Point GCR site farther west, and the site is therefore of key importance for revealing the nature of lateral facies changes through comparison both with the marginal facies at the Pant y Slade to Witches Point GCR, and with the correlative succession exposed on the south coast of the Bristol Channel at the Blue Anchor–Lilstock Coast GCR site.

The Blue Lias Formation strata in the Lavernock to St Mary's Well Bay section are folded into a gentle syncline, with the youngest strata exposed in the cliffs in the central part of the GCR site (Figure 3.2). The lower part of the Blue Lias Formation, exposed at the western and eastern ends of the site, has been named the 'St Mary's Well Bay Member'. It comprises typical Blue Lias Formation facies of alternating limestones and mudstones on a decimetre scale (Waters and Lawrence, 1987). It is succeeded by a mudstone-dominated sequence, called the 'Lavernock Shale Member' (Strahan and Cantrill, 1902), which forms part of the cliffs in the centre of the bay (Figure 3.2). This in turn is overlain by further Blue Lias Formation limestone–mudstone alternations representing the lower part of the Porthkerry Member (Waters and Lawrence, 1987). The site is the type locality for the St Mary's Well Bay Member and the Lavernock Shale Member.

The Lavernock to St Mary's Well Bay GCR site is the only site in south Wales at which the transition from the Triassic Penarth Group to the early Jurassic Blue Lias Formation is exposed and, as such, has attracted the attention of palaeontologists and stratigraphers for more than a century. Bristow and Etheridge (1873) provided vertical sections through the Penarth Group and Blue Lias Formation and Woodward (1893) gave a brief description. Further details were published by Strahan and Cantrill (1902, 1912). Richardson (1905) published a stratigraphical account of the lower part of the succession, but did not provide any detail of the succession above the Planorbis Zone. Trueman (1920) published a detailed account of the biostratigraphy and lithostratigraphy of the Lias here, which included an outcrop map and sketch section of the strata exposed in the cliff and foreshore. Hallam (1960a, 1964a) and Wobber (1965, 1966, 1968a,b) included the Lavernock to St Mary's Well Bay GCR section in their sedimentological and palaeoecological investigations of the south Wales Lias, and Wobber (1968a,b) provided a simplified graphic log for the entire section. Micropalaeontological investigations have been undertaken at this site (Wall, 1965; Copestake, 1989; Lord and Boomer, 1990) and elements of the bivalve fauna have been described from here (Hodges, 2000). Detailed accounts of the sections have been published by Waters and Lawrence (1987) and by Warrington and Ivimey-Cook (1995). Hodges (1994) published a detailed section through the basal Lias and described the biostratigraphy of ammonites and bivalves through this part of the succession. Bessa and Hesselbo (1997) have published gamma-ray logs for the site.

Description

Waters and Lawrence (1987) and Warrington and Ivimey-Cook (1995) have provided detailed descriptions of most of the succession exposed between St Mary's Well Bay and Lavernock Point. However, Trueman's (1920) account remains the only one that describes the stratigraphy of the upper part of the section in detail, and is the only complete section to have been published. The section reproduced here is based upon Waters and Lawrence (1987) and Trueman (1920) (Figure 3.3). The base of the Blue Lias Formation has been taken at the base of a 0.2 m-thick, well-laminated, silty mudstone, termed the 'Paper Shales', which rests on the Langport Member of the Penarth Group. Above lies a 3.1 m-thick succession of tabular limestones with subordinate mudstones (Figure 3.4) termed the 'Bull Cliff Member' (Waters and

Lawrence, 1987). Ammonites are absent from this part of the succession, referred to as the 'Pre-Planorbis Beds' in early accounts, and the fauna is dominated by the bivalve molluscs *Liostrea hisingeri* and *Modiolus minimus* together with abundant disarticulated remains of the echinoids *Diademopsis serialis* and *Eodiadema bechei.* The bivalve and echinoid remains occur in both limestones and mudstones, often as winnowed coquinas. The top of the Bull Cliff Member is taken at the base of the lowest nodular limestone, termed the 'Dual Bed'. There is a significant reduction in the limestone–mudstone ratio above the Bull Cliff Member and a corresponding decline in the abundance of oysters. The molluscan fauna is dominated by pectinid genera, including *Camptonectes, Chlamys, Oxytoma* and *Terquemia,* together with shallow-burrowing bivalves such as *Pinna* and *Plagiostoma giganteum.* Hodges (1994) noted the first common occurrence of the latter species in the Dual Bed, which he referred to as the 'Plagiostoma Bed'. Disarticulated remains of the crinoid *Isocrinus psilonoti* are also abundant locally while scattered spines and plates of the echinoid *Miocidaris lobatum* may be common, though inconspicuous. The first *Psiloceras planorbis,* marking the base of the Jurassic System, was recorded about 1.4 m above the Dual Bed (Hodges, 1994).

The succeeding 13.1 m, of typical Blue Lias Formation facies, with nodular or tabular argillaceous limestones alternating with calcareous mudstones (Figure 3.2), is the St Mary's Well Bay Member and has its stratotype at this GCR site. The limestones mostly are structureless, tabular or nodular calcllutites, or lines of discrete nodules, and are separated by blue-grey shaly mudstones. Both mudstones and limestones contain scattered fossil remains, mostly molluscan and echinoderm, and often are burrowed or bioturbated. Laminated mudstones and limestones occur at only three levels in the St Mary's Well Bay Member and form important marker bands. The lowest of these, termed the 'Planorbis Mudstones' by Waters and Lawrence (1987), lie about 7 m above the base of the bed and comprise 0.65 m of dark-grey fissile mudstone with abundant poorly preserved *Psiloceras planorbis.* The 'Lower Laminated Beds' lie about 1 m higher in the section, towards the top of the Planorbis Subzone, and comprise 0.7 m of fissile mudstone with a thin laminated limestone. Almost 2.5 m higher still, towards the middle of the Johnstoni Subzone, are the 'Upper Laminated Beds', comprising a distinctive 0.08 m-thick laminated limestone within a 0.9 m-thick fissile mudstone capped by a further thin laminated limestone. These laminated limestones and mudstones typically are organic-rich and lack evidence of burrowing or shelly benthos.

The uppermost 2.7 m of the St Mary's Well Bay Member has been assigned to the Liasicus Zone and is dominated by mudstones with only a few tabular or nodular limestones. The boundary with the overlying Lavernock Shale Member is arbitrary, and has been placed at the top of a tabular limestone bed, Bed 86 of Waters and Lawrence (1987). Here, at the stratotype section, the member is some 12 m thick but largely inaccessible (Figure 3.2). This part of the succession was recorded by Trueman (1920) on the basis of a log compiled from small exposures inland rather than from the cliff section itself. However, Waters and Lawrence (1987) considered Trueman's record of this part of the section to be unreliable and to contain errors of correlation and/or identification. It remains otherwise undocumented in any detail to the present day. The Lavernock Shale Member is dominated by grey calcareous mudstones with only a few thin nodular limestones. The sediments are fossiliferous and bioturbated, with a varied fauna of benthic molluscs, particularly bivalves such as *Cardinia listeri,* echinoderm debris and a few ammonites. The ammonites include *Waehneroceras portlocki* and *Psilophyllites hagenowi,* indicative of the Liasicus Zone. The top of the member is taken at the base of Bed 87 of Waters and Lawrence (1987), within about 2 m of where the dominantly mudstone sequence passes up into strata in which mudstones and nodular limestones occur in roughly equal proportions.

About 10 m of alternating limestone and shale of the Porthkerry Member is poorly exposed in the upper part of the cliff in St Mary's Well Bay. Much of this lies within the upper part of the Liasicus Zone, but Trueman (1920) reported a specimen of *Schlotheimia* aff. *thalassica* from near the top of the section, indicative of the Angulata Zone.

Fossil preservation throughout the Blue Lias Formation at this GCR site almost invariably is calcitic or pyritic.

Interpretation

Although the succession exposed at this site is fossiliferous and contains ammonites in much greater abundance than the marginal facies farther to the west, at the Pant y Slade to Witches Point GCR site, details of the biostratigraphy of parts of the section have only recently been clarified. Trueman (1920) assigned much of the Lavernock Shale Member to

the Angulata Zone on the basis of numerous fragments of supposed *Schlotheimia* spp. (presumably *Saxoceras* or immature *Waehneroceras*), and *Alsatites liasicus* from the uppermost part of the succession. However, the rationalization of the zonal stratigraphy of the Lias by Dean *et al.* (1961) resulted in the lower part of what had been the Angulata Zone becoming the Liasicus Zone. Wobber (1968a,b) continued to use Trueman's (1920) zonal divisions and considered the Liasicus Zone to be only 1.2 m thick at this GCR site. In addition, he claimed to have found *Vermiceras scylla* near the top of the section, indicative of the Rotiforme Subzone (Page, 1992), but this probably arose through mis-identification of *Alsatites.* The Lavernock Shale Member lies entirely within the Liasicus Zone and the strata preserved in the Lavernock outlier range no higher than the Angulata Zone (Waters and Lawrence, 1987).

The mudstone-dominated facies of the Lavernock Shale Member can be correlated with the St Audrie's Shales of the Blue Anchor–Lilstock Coast GCR site (Palmer, 1972; Warrington and Ivimey-Cook, 1995), the Saltford Shale Member of the Bristol district (Donovan, 1956; Donovan and Kellaway, 1984) and a more argillaceous part of the succession on the Dorset coast (Hesselbo and Jenkyns, 1995) (see (Figure 2.6), Chapter 2). This has been interpreted as evidence for a eustatic sea-level rise in Liasicus Zone times (Hallam, 1981). Bessa and Hesselbo (1997) noted that the gamma-ray logs for the Blue Lias Formation of the Somerset and south Wales coasts were similar, except close to the Planorbis–Liasicus zonal boundary where they inferred the St Mary's Well Bay section to be the more complete. Individual limestone beds can, in many cases, be traced for kilometres along the south Wales coast while the distinctive Lower Laminated Beds and Upper Laminated Beds were traced across to the Pinhay Bay to Fault Corner GCR site by Hallam (1960a, 1964a). The Paper Shales, taken as the base of the Blue Lias Formation here, have also been correlated with similar shales which comprise most of the Watchet Beds (Richardson, 1911) of the Blue Anchor–Lilstock Coast GCR site (Whittaker, 1978).

Wobber (1968b) recognized five offshore biofacies in the Blue Lias Formation of the south Wales coast on the basis of a broad range of sedimentological features. These included carbonate content, benthic oxygen levels, sedimentation rates and bioclastic content. He used these to identify marginal and offshore lithofacies and biofacies and to relate them to relative depths of deposition. Benthic oxygen levels seem rarely to have fallen sufficiently to exclude burrowing organisms, and there is a diverse shelly benthos at many levels. Wobber (1968b) noted that the faunas of the limestones and mudstones were similar. Disarticulation of echinoderms and the fragmentation of much molluscan shell material indicates moderate- to high-energy conditions at times. Wobber (1968b) also considered burrowing and scavenging organisms to be critical for disrupting stratification and reducing bioclastic debris size. Laminated benthos-free sediments are present at only three levels, all in the Planorbis Zone, but since at least two have been correlated across to the Pinhay Bay to Fault Corner GCR site they probably relate to climatic or sea-level changes rather than to local sedimentological factors.

The benthic fauna throughout the Blue Lias Formation exposed at this site, as elsewhere in the offshore facies of the south Wales Lias, is dominated by bivalve molluscs. Strongly ribbed bivalves are rare or fragmentary in the Lias at this site, suggesting that such remains are allochthonous here, whereas in the more marginal facies around Witches Point they are common and almost certainly autochthonous. Within the Lavernock section there is a clear ecological succession reflecting water depth and/or sedimentation rate. The abundance of the cemented *Liostrea hisingeri,* the byssate *Modiolus minimus,* and the algal-grazing echinoids *Diademopsis* and *Eodiadema, in* the limestone-dominated Bull Cliff Member suggests slow sedimentation and a firm substrate, perhaps with incipient hardgrounds. These epifaunal bivalves are largely replaced in the St Mary's Well Bay Member by shallow burrowers, such as *Plagiostoma,* and pectinids, indicating an increased sedimentation rate and a stable, well-oxygenated sea floor with gentle currents.

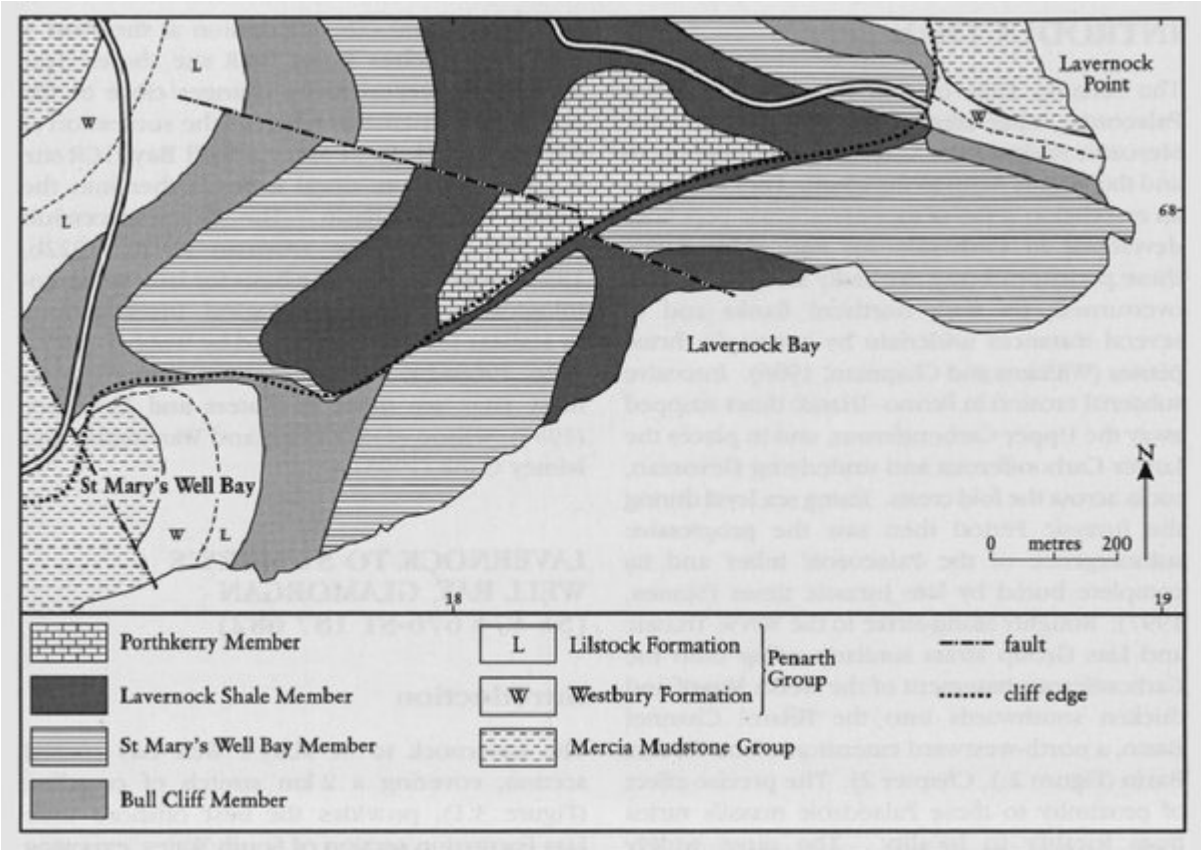
Pinna hartmanni occurs at a few levels and indicates more constant sedimentation rates during these intervals. The presence of deeper burrowing forms, notably *Cardinia listeri, in* the Lavernock Shale Member indicates a softer sea floor associated with a rise in sea level.

Conclusions

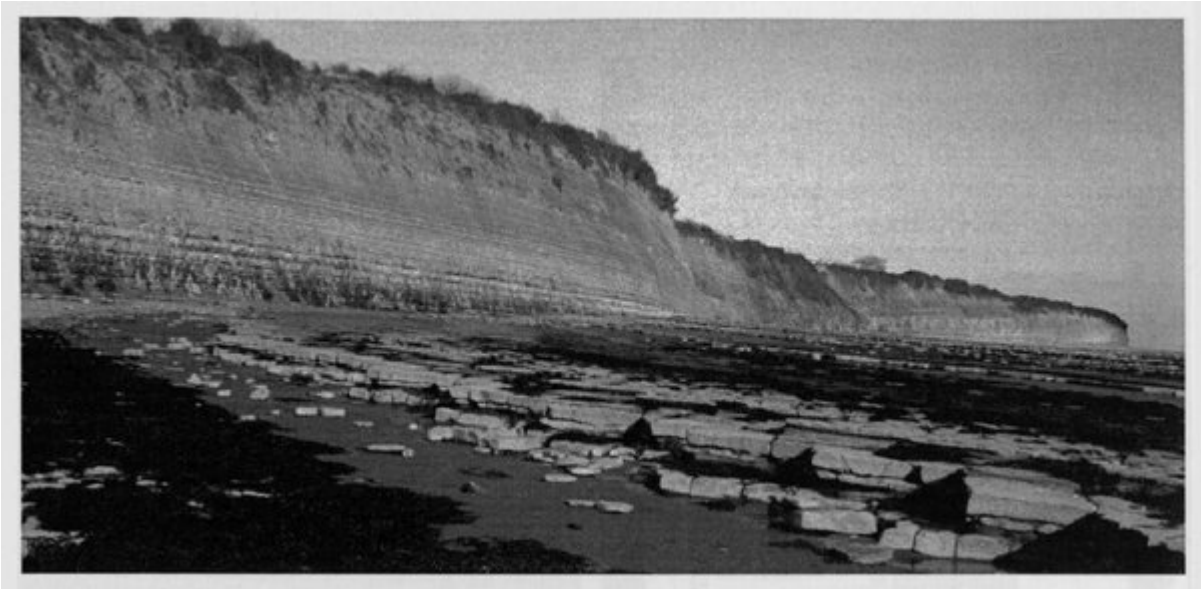
The Lavernock to St Mary's Well Bay GCR site exposes the most complete and representative section through the lower part of the Blue Lias Formation in south Wales from its boundary with the underlying Penarth Group. It records

particularly clearly the gradual change from the limestone-dominated Bull Cliff Member through to the mudstone-dominated Lavernock Shale Member, with corresponding faunal changes from a firm substrate epifauna to a soft substrate shallow infauna. Biostratigraphical correlation with the marginal facies of the Pant y Slade to Witches Point GCR site farther west, and correlative GCR successions on the Dorset and north Somerset coasts, provides a valuable insight into the nature of early Jurassic sedimentation on this basin margin.

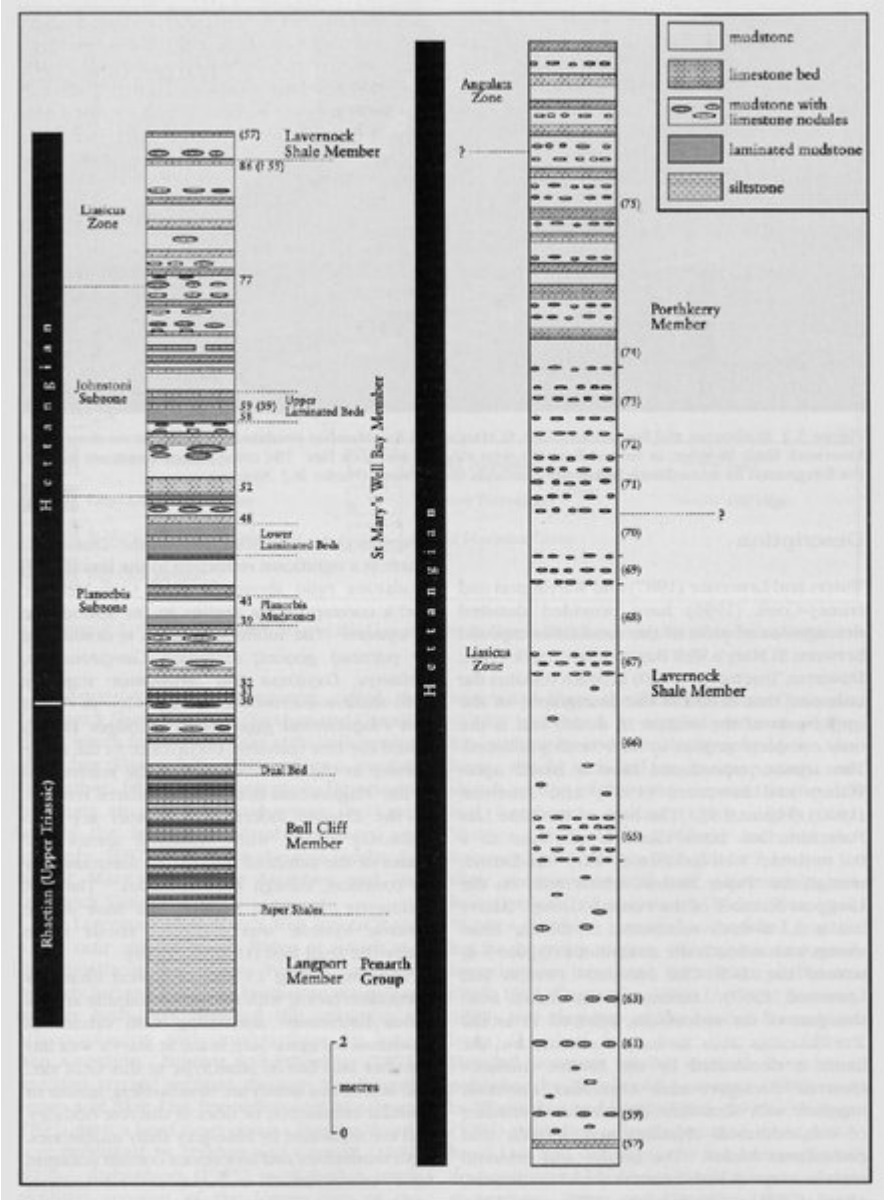
References



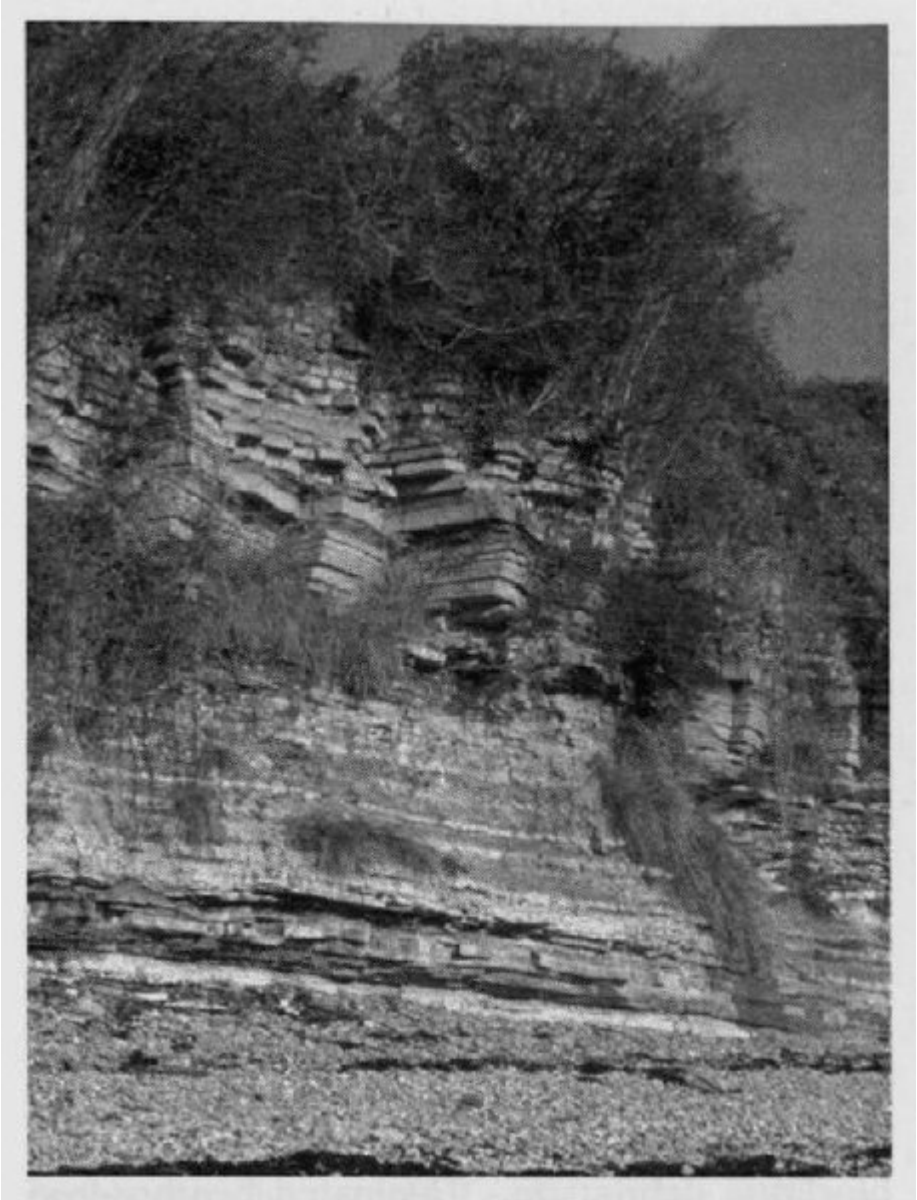
(Figure 3.1) Geological sketch map of the Lavernock to St Mary's Well Bay area. After Trueman (1920).



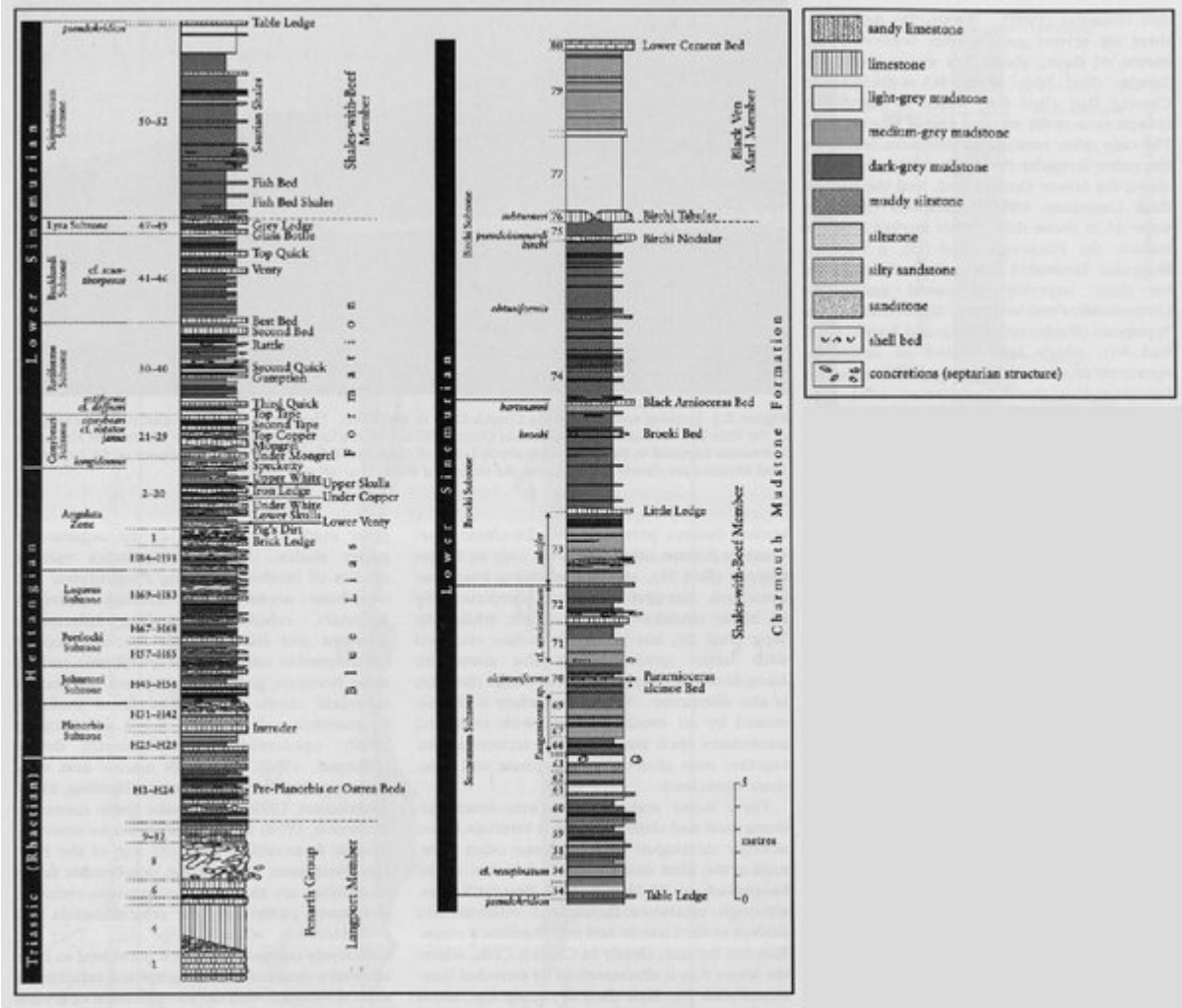
(Figure 3.2) Mudstones and limestones of the St Mary's Well Bay Member overlain by the mudstone-dominated Lavernock Shale Member, as viewed from the west side of Lavernock Bay. The conspicuous limestone beds in the foreground lie immediately below the Planorbis Mudstones. (Photo: M.J. Simms.)



(Figure 3.3) Section through the Blue Lias Formation in Lavernock Bay, based on Waters and Lawrence (1987) and Trueman (1920). The sequence through the Lavernock Shale and Porthkerry members has been compiled from Trueman's (1920) description and should be considered only provisional (see comments in main text). Bed numbers are those of Waters and Lawrence (1987), and Trueman (1920) in brackets.



(Figure 3.4) The section at St Mary's Well Bay, showing the conspicuous tabular limestones of the Bull Cliff Member in the upper part of the cliff overlying the silty mudstones of the Langport Member of the Penarth Group, with prominent sandstones in the Cotham Member visible near the base of the cliff. (Photo: M.J. Simms.)



(Figure 2.6) a. Section through the Penarth Group, Blue Lias Formation, Shales-with-Beef Member and basal Black Ven Marl Member west of Charmouth. After Hesselbo and Jenkyns (1995); with ammonite zones, sub-zones and biohorizons after Page (1992); and bed numbers after Lang (1924), Lang et al. (1923) and Lang and Spath (1926). b. Key to lithologies.