Blucks Pool–Bullslaughter Bay, Dyfed

[SR 890 976]–[SR 941 941]

Introduction

The Blucks Pool–Bullslaughter Bay GCR site encompasses more than 10 km of the south Pembrokeshire coastline from Blucks Pool [SR 890 976] southwards around Linney Head and then eastwards to Bullslaughter Bay [SR 941 941]. An almost complete Dinantian succession is exposed here; the thickest development of its kind in South Wales. Exposures are spectacular and abundantly fossiliferous. The site consists of precipitous cliffs and is entirely within the Castlemartin Artillery Range, both of which restrict access to the exposures, and the succession is therefore one of the least well known in the British Isles. The only description of the whole site is found in the [British] Geological Survey memoir (Dixon, 1921). More recent work has focused on particular parts of the succession, especially the stratotype for the Arundian Stage, which is at Hobbyhorse Bay, and on which correlations within the UK are based (e.g. George *et al.,* 1976; Ramsbottom, 1981; Simpson, 1985a).

Description

Dinantian strata are exposed on either limb of the Bullslaughter Bay Syncline, the axis of which runs east–west, intersecting the coast near Hanging Tar, north of Linney Head. The section is also considerably faulted. The total thickness of Dinantian rock in the area is approaching 1500 m (see, for example, George, 1974), the thickest succession in South Wales. The base and top of the Dinantian sequence are not exposed within the boundaries of the site, although the base can be found to the north at Freshwater West.

A large part of the succession in south Pembrokeshire is made up of interbedded bioclastic wackestones and calcareous mudstones. Within the site this includes the Courceyan Blucks Pool Limestone, the Chadian Berry Slade Formation and the Arundian Pen-y-Holt Limestone. The term 'zaphrentid-phase' was used for this distinctive rhythmically bedded facies of southern Britain by Vaughan (1910) and Dixon (1921), because it is particularly rich in solitary corals. This facies in Pembrokeshire was further described by Sullivan (1966) who noted that chert and dolomitized limestones are sometimes present. Dixon (1921) provides full faunal lists, but the principal characteristics of the fauna are summarized by Sullivan (1966). He noted an abundant and diverse fauna of corals, brachiopods, crinoids and bryozoans, with trilobites, bivalves, gastropods and foraminifera more local in occurrence. The most obvious fossils are the solitary corals, which include *Rotiphyllum, Allotropiophyllum, Cryptophyllum, Cyathaxonia* and *Zaphrentites.* Brachiopods are also abundant and include spinose productoids, chonetoids, orthotetoids, frilled athyrids, rhipidomellids and schizophoriids.

There are two features of special interest within the 'zaphrentid-phase' at this site. The first is the occurrence of 'reefs' in the west-facing cliffs between Berry Slade and Linney Head. Dixon (1921) and Sullivan (1966) recorded reefs at two levels within the Chadian Berry Slade Formation (George *et al.,* 1976), but the lower, thicker development is entirely dolomitized. According to Sullivan (1966), the lower, main reef at Linney Head is approximately 75 m thick. Fine to medium crystalline dolomite has obscured the original reef textures and constituents, with the exception of some crinoid debris. Petrography and geochemistry of the reef dolomites were studied by Faulkner (1989a). The contact of the reef with the surrounding bedded limestones is sharp and steep, with evidence of local erosion surfaces and reef debris at the contact.

Sullivan (1966) described smaller lens-shaped reefs which he considered to occur above the reef dolomites. These are composed of pale-coloured, peloidal carbonate muds with the remains of crinoids, brachiopods, bryozoans, ostracodes, calcispheres and foraminifera. These small reefs pass laterally into crinoidal limestones which then grade laterally into the normal dark-coloured 'zaphrentid-phase' limestones. The top contacts of these structures are sharp, with evidence of local erosion (Sullivan, 1966). Lees and Miller (1985), in their review of Waulsortian buildups in Europe and America, recognized their phases C and D in these small structures.

However, In their field guide notes, Ramsbottom and Jones (1977) disputed the presence of reefs at two stratigraphical levels and regarded it as a single occurrence repeated by faulting. Ramsbottom and Jones (1977) also list conodont faunas from the reef and from the beds that occur immediately above and below it.

The second feature of interest within this part of the succession is the stratotype for the Arundian Stage, which was defined by George *et al.* (1976) at the base of the Pen-y-Holt Limestone where it is seen in contact with dolomitic beds at the top of the crinoidal Hobbyhorse Bay Limestone in Hobbyhorse Bay [SR 888 956] (Figure 9.18). This corresponds with the base of the 'Group 4' beds of Dixon (1921). George *et al.* (1976) took the boundary at the first change in lithology below the entry of typical Archaediscidae, especially *Permodiscus* (now *Uralodiscus*) (see also Ramsbottom, 1981). Characteristic macrofossils of the Arundian Stage at Hobbyhorse Bay include *Delepinea carinata, D. destinezi, Pustula pyxidiformis, Siphonodendron martini, Siphonophyllia garwoodi, Michelinia megastoma* and early koninckophylloids (George *et al.,* 1976). Conodonts from the stratotype have been described by Austin (1987), who noted the appearance of the Arundian guide *Gnathodus symmutatus* just above the base of the Pen-y-Holt Limestone. The foraminiferal biostratigraphy of the stratotype was studied by Simpson and Kalvoda (1987). They noted a diverse Chadian assemblage in the Hobbyhorse Bay Limestone, but, according to them, Arundian archaediscids do not appear until 16 m above the stratotype boundary. Simpson and Kalvoda (1987) also recognized a transitional facies change from packstones to wackestones within the limestones of the lower part of the Pen-y-Holt Limestone.

Simpson (1985a, 1987) has described the whole 300 m succession of the Pen-y-Holt Limestone in South Wales, including the accessible parts of the section between Hobbyhorse Bay and The Wash in this site. He described an alternation of wackestones and carbonate mudstones, the former being dominated by sharp-based unlaminated beds averaging 40 cm in thickness with some thin laminated units less than 5 cm in thickness. The trace fossils *Zoophycus, Teichichnus, Thalassinoides* and simple vertical tubular burrows are common near the tops of the unlaminated wackestones. Body fossils are fragmented within the units, but include organisms in *situ* at the tops of beds, including *Syringopora, Michelinia, Schizophoria resupinata, Cleiothyridina roysii, Schellwienella crenistria* and spiriferoids. The carbonate mudstones contain similar trace fossils to the wackestones together with a few *Chondrites* and a body fossil fauna that includes solitary corals, lengths of crinoid stem with articulated calices, echinoid tests, fenestellid bryozoans and complete trilobite skeletons.

The Arundian–Holkerian boundary was taken by George *et al.* (1976) at the base of the more massive limestones of the Stackpole Limestone Formation. However, on the basis of a record of the Holkerian foraminifer *Draffnia biloba within* the upper part of the 'zaphrentid-phase' limestones, Scott (1988) placed the boundary lower, at the junction between the 'Group 8' and 'Group 9' beds of Dixon (1921) and within the Pen-y-Holt Limestone. The Green Bridge of Wales [SR 925 943] shows the transition between the 'zaphrentid-phase' facies and the more massive bioclastic limestones typical of the Holkerian Stage at this site. Medium-bedded crinoidal limestones make up most of the Stackpole Limestone Formation; in the lower part of the succession they tend to be wackestones with little disarticulation of crinoidal material, but higher up there is less matrix and signs of winnowing are more apparent (Scott, 1988). The topmost part of the Stackpole Limestone Formation consists of oolitic and peloidal limestones.

The Asbian and Brigantian succession at this site has received little attention since the work of Dixon (1921). The Asbian Crickmail Limestone is seen mostly in cliff sections of difficult access; Dixon (1921) records it as consisting of thick limestones and thin clays. The contact between the Crickmail Limestone and the Bullslaughter Limestone can be seen on the east side of Bullslaughter Bay [SR 939 943]. Dixon (1921) recorded the Crickmail Limestone as being pale grey and relatively pure, with fewer fossils than in the overlying beds, but containing frequent *Davidsonina septosa* near the top. The overlying Bullslaughter Limestone consists of thinly bedded dark limestones with abundant chert and silicified fossils. Dixon (1921) recorded the presence of some paler crinoidal and oolitic limestones and noted that, amongst the fossils, zaphrentids were particularly common. Overall, the Asbian and Brigantian strata at this site appear to be of similar facies and thickness to the Oxwich Head Limestone (George *et al.,* 1976) (Figure 9.2).

Interpretation

Wright (1986a) has proposed that, at least for the Courceyan to Arundian interval, South Wales was occupied by a southerly dipping carbonate ramp ((Figure 9.3)a). Reconstructions for Pembrokeshire (e.g. Sullivan, 1966) suggest that southern Pembrokeshire, including this site, lay on the most distal exposed part of the ramp and hence received the thickest and most continuous deposition. The succession thus represents deeper-water deposits, typified by the 'zaphrentid-phase' limestones, compared to the equivalent successions elsewhere in South Wales. For example, shallow-water deposits of the Chadian Stage, such as the Caswell Bay Oolite–Gully Oolite and Caswell Bay Mudstone, present in most of South Wales, are not seen at this site. Clearly, however, depths were sufficiently shallow to allow an abundant and diverse fauna to flourish.

Mid-Dinantian buildups commonly occupy the deeper part of ramps, and Lees and Miller (1985) interpreted phases C and D of Waulsortian facies, as present at Hanging Tar, as having formed at water depths of 100–250 m. Dolomites from the reef facies were interpreted as the product of burial diagenesis with fluids sourced from basin de-watering by Faulkner (1989a). Simpson (1987) interpreted the depth of the ramp in south Pembrokeshire during Arundian times as being about 100 m. He interpreted the thick unlaminated wackestones as being storm deposits, with their top surfaces colonized by various burrowing organisms and by the organisms whose skeletons are found in *situ* on the surfaces. He interpreted the mudstones to be background pelagic deposits with an autochthonous fauna.

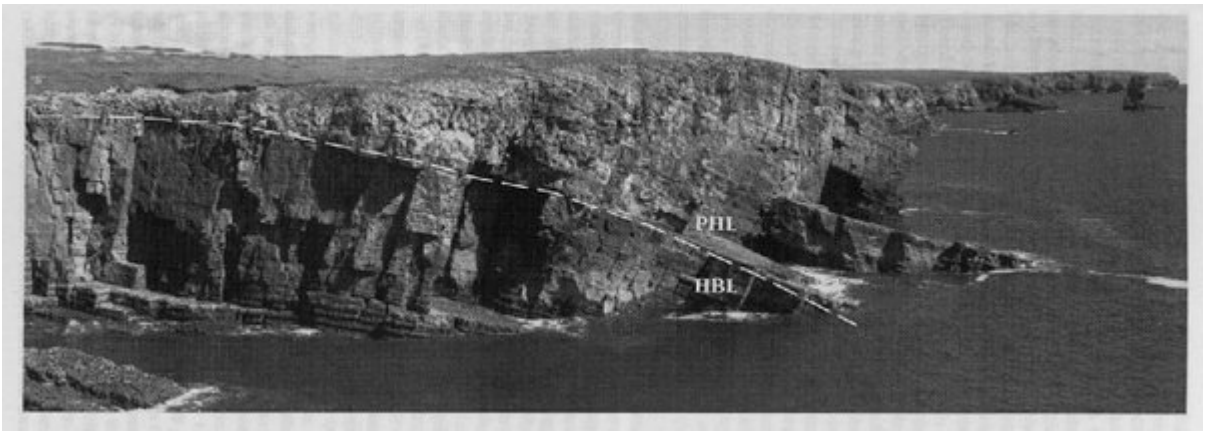
The status of the Arundian stratotype has been discussed by Riley (1993) who highlighted the fact that the lowest 16 m of the stratotype lacked a diagnostic Arundian fauna and was thus indistinguishable from the late Chadian succession. Riley (1993) also discussed the possiblity of moving the stratotype to the level at which primitive archaediscids made their first entry without moving the stratotype from Hobbyhorse Bay.

The Holkerian sequence in South Wales oversteps older deposits, indicating regional unconformity at the base of the Holkerian Stage (as in the Lake District, North Wales and the Craven Basin; see Barker Scar GCR site report, Chapter 4, and Dowshaw Delf Quarry GCR site report, Chapter 6), followed by overall subsidence and transgression (George, 1974). This unconformity also occurs in the former Soviet Union and the USA (N. Riley, pers. comm., 2002). However, in south Pembrokeshire, the Holkerian succession overall records shallowing from the zaphrentid-phase limestone, through crinoidal limestones showing increasing signs of current activity upwards, to oolitic and peloidal deposits interpreted as part of a barrier complex by Scott (1988). The Asbian and Brigantian stages of the area are not well known, but they appear to represent similar environments to those on Gower, with shallow marine bioclastic limestones punctuated by episodes of emergence and the development of clay palaeosols.

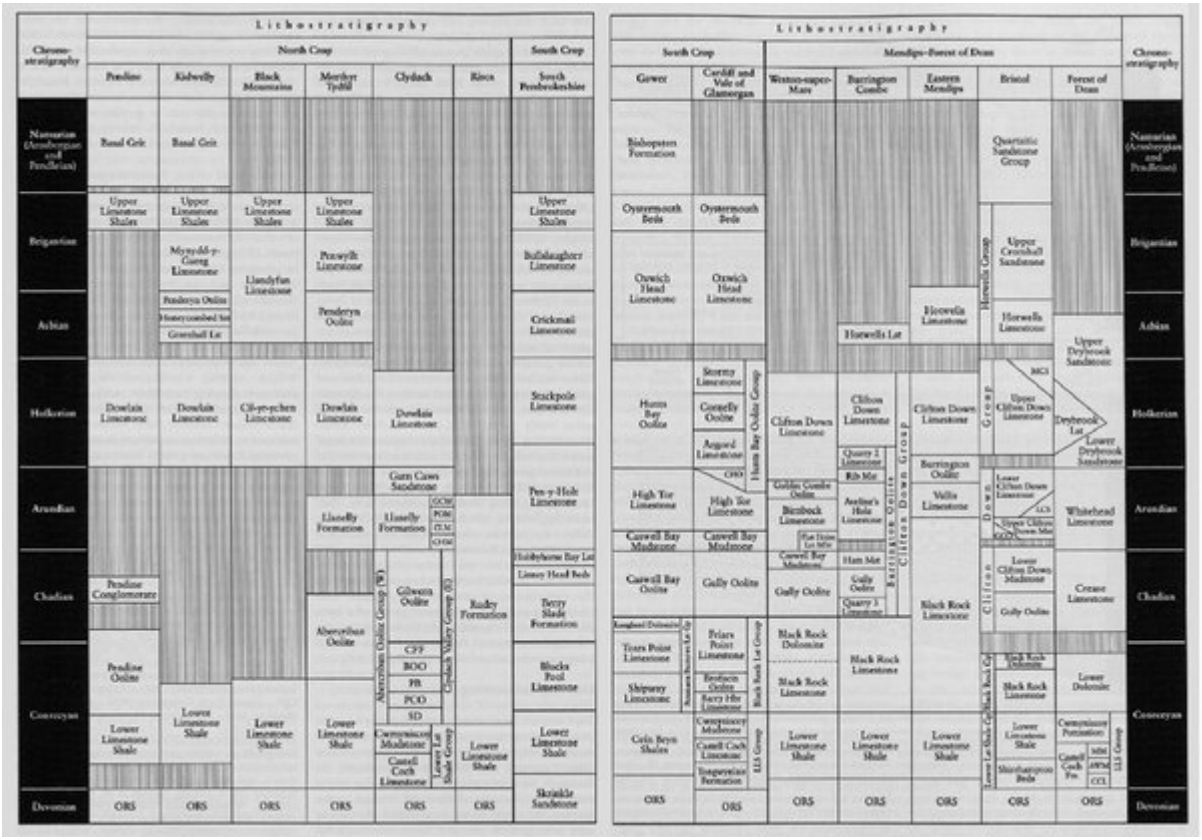
Conclusions

This site shows spectacular exposures of much of the Dinantian succession in south Pembrokeshire. The facies are different to those elsewhere in South Wales, with a thick development of deeper-water 'zaphrentid-phase' limestones containing an abundant and diverse fauna. In addition, the associated reef structures are unique in the Lower Carboniferous sequences of South Wales. The locality also contains the stratotype of the Arundian Stage, which is the standard for the correlation of successions of this age throughout the British Isles. The site offers much potential for future palaeontological, stratigraphical and sedimentological research.

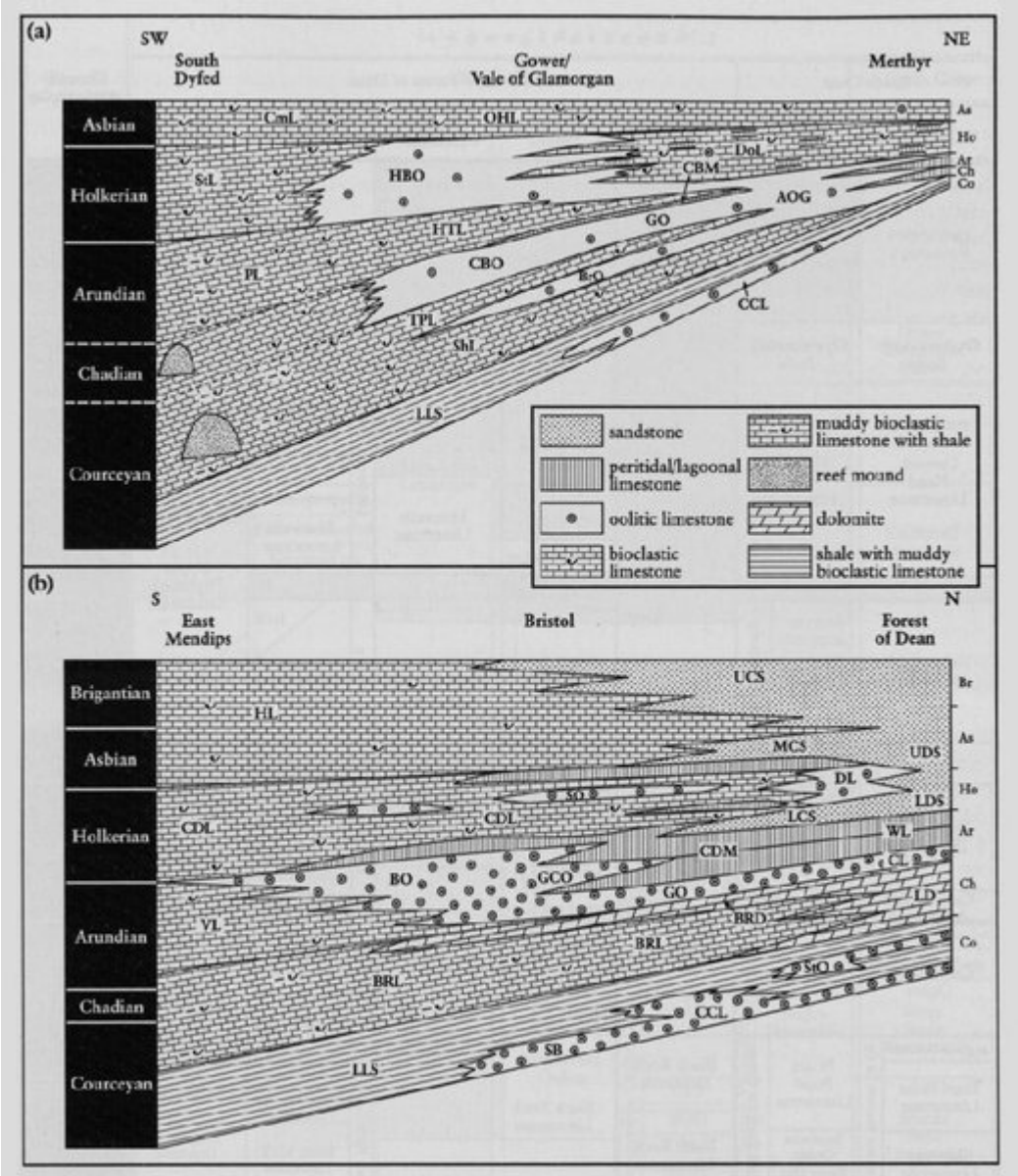
References



(Figure 9.18) The Arundian Stage stratotype at Hobbyhorse Bay. The base of the stage is defined at the boundary between the top of the Hobbyhorse Bay Limestone (HBL) and the base of the overlying Pen-y-Holt Limestone (PHL). (Photo: S. Howells.)



(Figure 9.2) Simplified stratigraphical chart illustrating the most widely used lithostratigraphical terms for the Lower Carboniferous sequences in South Wales, the Forest of Dean, Bristol and the Mendips. (SD — Sychnant Dolomite; PCO — Pwil y Cwm Oolite; PB — Pantydarren Beds; BOO — Blaen Onnen Oolite; CFF — Coed Ffyddlwn Formation; CHM — Clydach Halt Member; CLM —Cheltenham Limestone Member; POM — Penllwyn Oolite Member; GCM — Gilwern Clay Member; LIS —Lower Limestone Shale; CHO — Cefnyrhendy Oolite; CCL — Castell Coch Limestone; AWM — Astridge Wood Member; MM — Mitcheldean Member; GCO — Goblin Combe Oolite; LCS — Lower Cromhall Sandstone; MCS — Middle Cromhall Sandstone.) Areas of vertical ruling indicate non-sequences. Not to scale. Based on information from and after Welch and Trotter (1961), Green and Welch (1965), Institute of Geological Sciences (1973, 1977c), George et al. (1976), Wright (1982b), Whittaker and Green (1983), Burchette (1987), Waters and Lawrence (1987), Barclay et al. (1988), Scott (1988), Barclay (1989), Wilson et al. (1990) and Kellaway and Welch (1993).



(Figure 9.3) Simplified stratigraphical sections of Dinantian strata in south-west Britain illustrating the distribution of Dinantian lithofacies. Section (a) based on Wright (1986a) and Burchette et al. (1990); approximate length of section, 100 km. Section (b) based on information from Kellaway and Welch (1955, 1993), Burchette et al. (1990) and Green (1992); approximate length of section, 80 km. (LLS — Lower Limestone Shale; CCL — Castell Coch Limestone; ShL — Shipway Limestone; BrO — Brofiscin Oolite; TPL — Tears Point Limestone; CBO Caswell Bay Oolite; GO — Gully Oolite; AOG — Abercriban Oolite Group; CBM — Caswell Bay Mudstone; PL — Pen-y-Holt Limestone; HTL — High Tor Limestone; StL — Stackpole Limestone; HBO — Hunts Bay Oolite; DoL — Dowlais Limestone; CmL — Crickmail Limestone; OHL — Oxwich Head Limestone; SB — Shirehampton Beds; StO — Stowe Oolite; BRL — Black Rock Limestone; BRD — Black Rock Dolomite; LD — Lower Dolomite; CL — Crease Limestone; VL — Vallis Limestone; BO — Burrington Oolite; GCO — Goblin Combe Oolite; CDM — Clifton Down Mudstone; WL — Whitehead Limestone; CDL — Clifton Down Limestone; SO — Seminula Oolite; DL — Drybrook Limestone; LDS — Lower Drybook Sandstone; UDS — Upper Drybook Sandstone; LCS — Lower Cromhall Sandstone; MCS Middle Cromhall Sandstone; UCS — Upper Cromhall Sandstone; HL — Hotwells Limestone.)