Llanelly Quarry, Gwent

[SO 222 123]–[SO 225 123]

Introduction

The Llanelly Quarry GCR site is a disused quarry [SO 2223 1237]–[SO 2250 1233], 3 km east of Brynmawr. It is the type section for the Arundian Llanelly Formation, and is the best developed example of the shallowest-water marine deposits known from the Lower Carboniferous rocks of South Wales. The main part of the quarry covers a succession that is Courceyan to Holkerian in age. Besides displaying a range of distinctive limestone types, there are also four levels that show different types of exposure features, formed when sea levels were low enough for the area to be exposed to weathering and soil formation. These provide unusually clear evidence of changes in soil development due to both climatic changes and sea-level rise. The site also includes the transition from the non-marine Old Red Sandstone into the shallow marine Lower Carboniferous succession. George (1954) provided the earliest detailed description of the succession in the area. Detailed descriptions of the sedimentology of the Llanelly Formation were given by Wright (1981a), and the stratigraphy of the whole Lower Carboniferous succession was revised by Barclay (1989).

Description

The site was probably worked intermittently from 1863 until 1963, and displays a range of early industrial features (van Laun, 1979, 2001). It includes a steep stream section, Nant Sychnant, which exposes a near-continuous succession from the Old Red Sandstone through the Castell Coch Limestone and Cwmyniscoy Mudstone (Lower Limestone Shale Group) and into the lower part of the Clydach Valley Group (Burchette, 1981; Barclay, 1989) ((Figure 9.6)a). A complex range of lithologies is present in the stream section below the quarry road (Castell Coch Limestone), representing the transition from continental deposition with fluvial sandstones and floodplain palaeosols, to lagoonal and shoreline deposits (Lovell, 1978; Burchette, 1981). In exposures immediately upstream of the road crossing there are dark shales (Cwmyniscoy Mudstone) with graded sandstone storm beds. Immediately adjacent to the quarry entrance are dolomitized, bedded limestones in which faint microbial lamination can be seen. These limestones, and small exposures in the disused railway cutting in front of the quarry, represent the Coed Ffyddlwn Formation (Barclay, 1989) ((Figure 9.6)a).

The main quarry faces (Figure 9.7) are unstable because thickly bedded Dowlais Limestone overlies soft, recessive clays in the Llanelly Formation. Great care should be exercised when examining the main exposure. These faces expose the upper part (at least 5 m) of the massive Gilwern Oolite, overlain by the Lianelly Formation. The junction of these two units is seen by the change from massive, brilliant white (when fresh), very well-sorted oolitic grainstones, to medium-bedded, fine-grained limestones of the Cheltenham Limestone Member of the Llanelly Formation (see below). The junction is irregular and is marked by varying degrees of dissolution features, including small solution pits, caverns up to 1 m wide and 0.3 m high at the western end of the quarry, to pipes at the eastern end (illustrated in Wright, 1982a, but now completely buried by clay and rubble which has fallen from the upper part of the formation). The upper half of the quarry is composed of thickly bedded limestones of the Dowlais Limestone.

The Llanelly Formation rests on the Gilwern Oolite, but as a result of intra-Carboniferous uplift, erosion and overstep, the Gilwern Oolite thins westwards until the Llanelly Formation lies directly on lower units in the Clydach Valley Group (George, 1954; Barday, 1989). The age of the Gilwem Oolite is problematic (Barclay, 1989), with macrofossils from the Coral Bed at its base indicating an Arundian age, but foraminifera and conodonts suggesting a Chadian age.

The quarry is the type section for the Llanelly Formation (George *et al.,* 1976) and has produced foraminifera (Barclay, 1989) and conodonts (Stone, 1991) indicating an Arundian age. This formation contains four members (Wright, 1981a), but only three of these are well developed at the quarry. Immediately above the irregular top of the Gilwern Oolite is a thin unit (*c.* 0.2 m) representing the basal member of the Llanelly Formation, the Clydach Halt Member (Wright, 1981a). Whereas this member contains prominent palaeosol horizons at many other localities in the area (Wright, 1982b), here it consists of less than one metre of interbedded conglomerates, with thin sandstone lenses, and thin clay interbeds, the latter containing lithoclasts of cemented oolitic grainstones, calcrete microspar and micrite. This unit is only patchily developed in depressions along the irregular surface of the Gilwem Oolite.

The bulk of the formation is composed of the second member, the Cheltenham Limestone Member ((Figure 9.6)b). This well-bedded unit (*c.* 9 m thick) consists of a variety of shallow-water limestones with a restricted biota. Lithologies include centimetre-thick bioclastic and intraclastic grainstones with open marine biotas, peloidal grainstones, packstones and wackestones with ostracodes and vermiform gastropod (?microconchid — see Weedon, 1990, 1991) debris, small (< 20 cm thick) porostromate-vermiform gastropod bioherms, fenestral laminated micritic limestones, centimetre-thick green clays and calcrete horizons. Two of the latter can be traced to other outcrops in the area and are worthy of note. At 8 m above the base of the formation is a prominent calcrete crust horizon that is up to 20 cm thick, named the 'Darrenfelen Geosol' by Wright (1983) ((Figure 9.6)b). It contains abundant small peloids and millimetre-sized burrows, faecal material, small rhizocretions and a range of other pedogenic microfabrics. Approximately 8.6 m above the base is a thin (15 cm) truncated calcrete horizon (the Cwm Dyar Geosol of Wright, 1982b) ((Figure 9.6)b) which is locally absent. This horizon marks the top of the Cheltenham Limestone Member in this section.

The overlying Penllwyn Oolite Member is 4 m thick ((Figure 9.6)b) and consists of oolitic and peloidal grainstones with grain aggregates. At the base is a coarse bioclastic unit (the 'Uraloporella Bed' of Wright, 1981a) a few centimetres thick which contains a diverse skeletal assemblage including rare large oncoids, and the problematic fossil *Uraloporella variabilis* (Wright, 1982c). The top of this member is a highly irregular surface.

The Penllwyn Oolite Member is overlain by the Gilwem Clay Member ((Figure 9.6)b), an 8 m-thick unit composed of soft clays with platy calcrete near the base and with horizons in which calcrete nodules are concentrated. There are pseudo-anticlinal slip planes developed in the clays, especially in the lower half of the unit. The upper part of the member lacks calcrete nodules and the top is marked by a brown-weathering ferroan dolomite rootlet bed up to 0.6 m thick, capped by a medium-grained sandstone up to 20 cm thick. A thin coal horizon is present locally beneath the sandstone. This sandstone is overlain by the very thick, argillaceous limestones of the Dowlais Limestone (Figure 9.7). The Dowlais Limestone is of Holkerian age (Barclay, 1989).

Interpretation

This is an important site for several reasons. Firstly the stream section provides a unique opportunity to examine the complexities of the transition from the continental Old Red Sandstone into the shallow marine Lower Carboniferous strata. Burchette (1981) has provided a detailed log of the changing environments as a mixed carbonate–clastic shoreline system developed over the area. The dark shales and graded beds above the road crossing probably represent offshore, deeper ramp deposits with storm beds. These shales may represent the deepest water conditions experienced by the area during Late Palaeozoic times. The Coed Ffyddlwn Formation is a series of limestones, heavily dolomitized, representing peritidal deposits, similar to the Llanelly Formation.

However, it is the Gilwern Oolite and Llanelly Formation that represent the main interest at this site. The top of the Gilwern Oolite is a major subaerial exposure surface representing a palaeokarst. The distinctive piping found at the eastern end of the section (now buried and requiring excavation) probably formed under a humid climate, and yet is overlain, at other localities, by up to six well-developed calcrete profiles, indicating formation under a semi-arid climate. Thus a climate change took place at this level (Wright, 1982a) prior to the return to marine conditions represented by the two middle units of the formation.

The regional importance of the Llanelly Formation rests on it being the best single outcrop illustrating the range of lithologies associated with the most proximal, inner-ramp settings of the Lower Carboniferous sequence in South Wales (Wright, 1986a). It contains a mixture of subaerial, alluvial and peritidal deposits indicating the complex interplay of sea-level and climate changes that characterize deposition in marginal marine settings. The Clydach Halt Member, by comparison, represents a thin alluvial, lowstand unit, produced by the interplay of the Chadian–Arundian sea-level lowstand and local tectonic effects.

The Cheltenham Limestone Member is a peritidal unit composed mainly of very shallow, restricted lagoonal deposits. Thin intercalations of fully marine limestones occur but are minor in volume (Wright, 1981a). Laminated, fenestral limestones represent deposition in intertidal settings. The green clays are problematic. Throughout the outcrop area of the member, the calcretes are found with green clays, but not all the green-clay horizons show evidence of palaeosol development. Thus their exact significance is unresolved. These lithologies are only weakly cyclic and are not comparable to classical peritidal deposits.

The Darrenfelen Geosol is remarkable for the preservation of abundant faecal pellets (peloids) of soil animals. Even well-preserved burrows are present, attributable to soil animals, probably mites (Wright, 1983, 1987b). The Cwm Dyar Geosol, although truncated at this locality, is a prominent unit in the area and represents a well-developed calcrete. This palaeosol probably represents a longer period of subaerial exposure than the Darrenfelen Geosol, and the relation ship of the two has been interpreted as indicating decreasing rates of accommodation space creation through the member, indicating deposition in a highstand system tract (Wright, 1996).

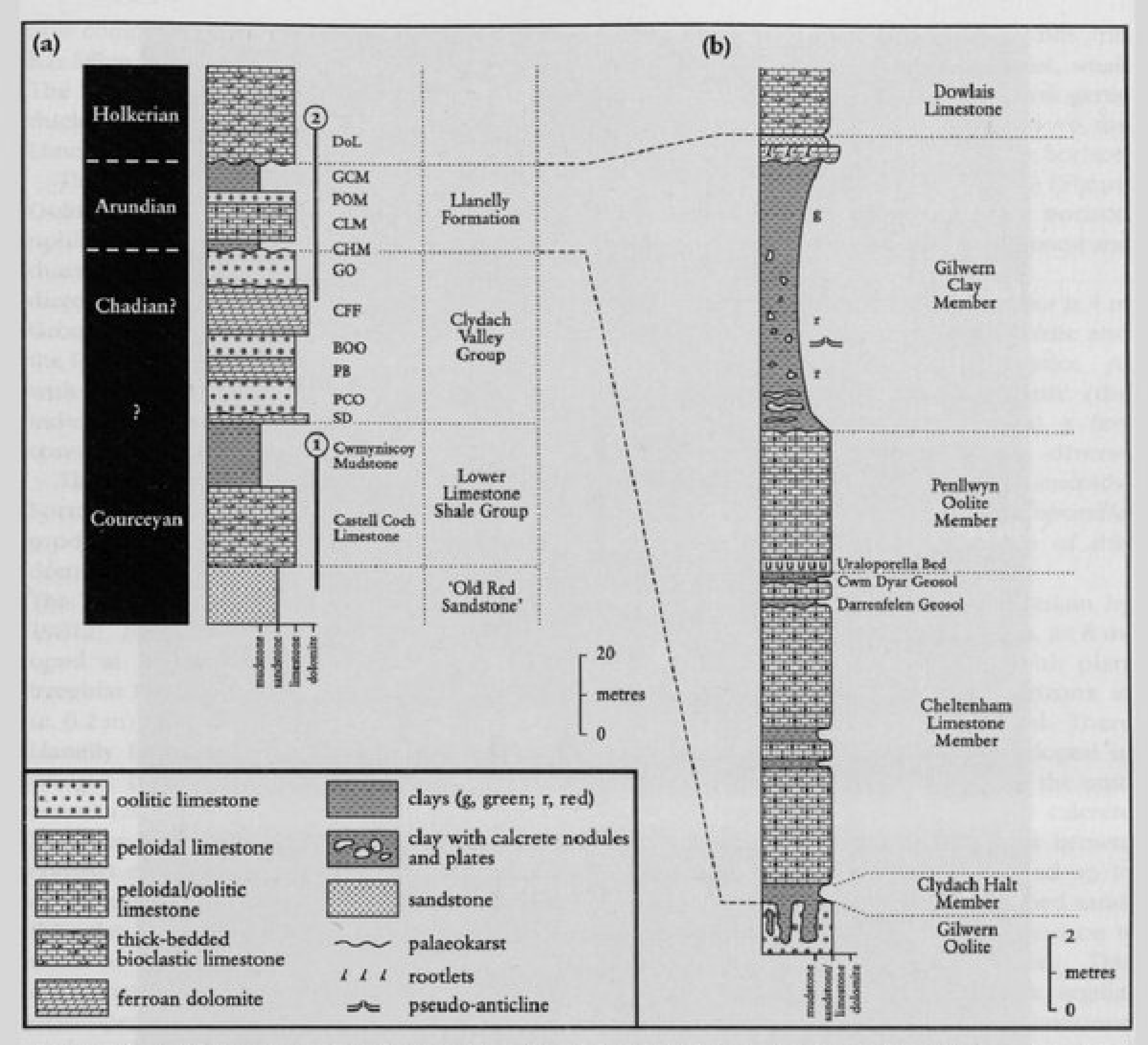
The Penllwyn Oolite Member is a back shoal deposit with a bioclastic basal unit containing the rare problematic *?alga Uraloporella variabills*, the first reported occurrence of this species in Britain (Wright, 1982c). The member represents a minor transgressive phase.

The Gilwern Clay Member represents three different palaeosol associations that provide evidence of lowstand deposition and of climate change during late Arundian times. The lower part, with abundant calcrete nodules and pseudo-anticlines, marks a slowly aggrading floodplain under a strongly seasonal, semi-arid climate. This is overlain by a green, calcrete-free unit with evidence of seasonal but wetter conditions. This shift in climate has also been recorded in the Bristol area, and is the first indication of shifts in seasonal moisture budgets in late Palaeozoic times, which is a motif that characterizes the later Carboniferous Period. The top of the unit, with a horizon of ferroan dolomite, represents marine flooding and the development of a brackish marsh environment. This is the best outcrop example of this feature, which is typical of transgressive sequences throughout the earliest part of the Lower Carboniferous succession in South Wales. The palaeosols in the member have been discussed in detail by Wright and Robinson (1988) and Wright *et al.* (1991).

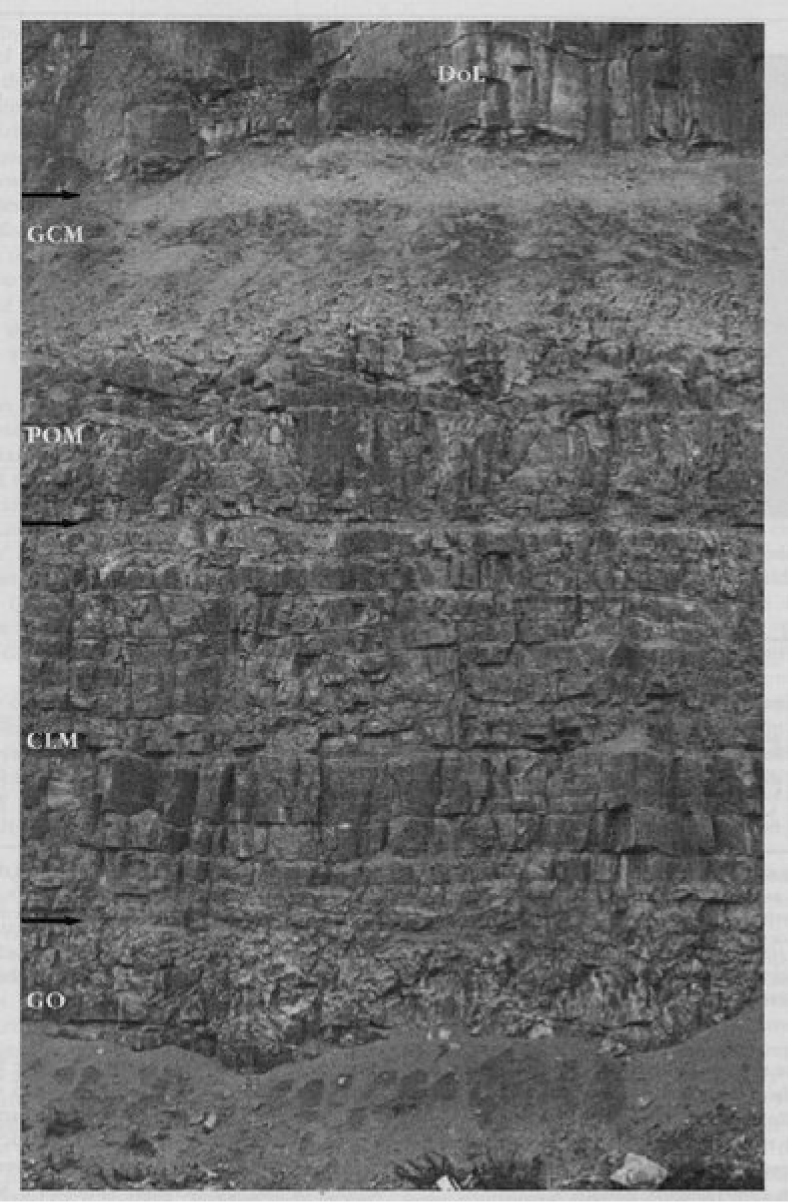
Conclusions

Llanelly Quarry provides a unique opportunity to examine the nature of deposition along the margins of the early Carboniferous basin in southern Britain. The stream section exposes the details of the transition from non-marine to marine environments during earliest Carboniferous times, whereas the rest of the section, besides being the type section for the Llanelly Formation, reveals the characteristic facies assemblages of inner-ramp deposits. In addition, the site contains exposures of palaeokarst and palaeosols that provide clear evidence of the climate changes that took place during early Carboniferous times. The Darrenfelen Geosol gives a unique glimpse of the soil biota during this time.

References



(Figure 9.6) (a) The Lower Carboniferous succession of the Clydach area illustrating the positions of the main sections exposed at the Llanelly Quarry GCR site (1 — Nant Sychnant section; 2 — Llanelly Quarry section. SD — Sychnant Dolomite; PCO — Pwyll-y-Cwm Oolite; PB — Pantydarren Beds; BOO — Blaen Onnen Oolite; CFF — Coed Ffyddlwn Formation). After Barclay (1989). (b) Details of the Llanelly Formation succession at Llanelly Quarry. The formation extends from the base of the Clydach Halt Member to the base of the Dowlais Limestone. The units of special interest here are the Darrenfelen Geosol and the Gilwern Clay Member. After Wright (1981a). Note, the key relates specifically to Figure (b) only.



(Figure 9.7) The main face at the Llanelly Quarry GCR site. The illustrated section extends from the top of the Gilwem Oolite (GO) through the overlying Llanelly Formation (CLM — Cheltenham Limestone Member; POM — Penllwyn Oolite Member; GCM — Gilwem Clay Member) and into the Dowlais Limestone (DoL). The lower arrow marks the position of an erosion surface/palaeokarst at the top of the Gilwern Oolite and the base of the Llanelly Formation, while the upper arrow marks the base of the Dowlais Limestone and the top of the Llanelly Formation. The middle arrow indicates the position of the Cwm Dyar Geosol at the top of the Cheltenham Limestone Member. (Photo: VP Wright.)