Viverdon Down Quarry, Cornwall

[SX 374 675]

Introduction

The Viverdon Down Quarry GCR site is a small disused chert quarry [SX 374 675] near St Mellion, in east Cornwall. It is surrounded by coarse-grained sandstones that comprise the largest and most southerly Carboniferous outlier in Britain. The site reveals a Lower Carboniferous conodont-bearing chert succession that forms part of a discrete block within the sandstones. Hinde and Fox (1895) first mentioned the cherts in the context of their research into radiolarians, but the presence of conodonts was not recorded until Matthews (1961, 1966a, 1969) described the diverse fauna and discussed its stratigraphical implications. During a more recent regional mapping programme Devonian rocks were discovered at the site (Whiteley, 1981, 1983).

Description

The area of relatively high ground north of St Mellion is called Viverdon Down and it comprises mainly Lower Carboniferous sandstones and shales known locally as the 'Crocadon Formation' (Whiteley, 1983, 1984). The formation is probably 150–250 m thick and it is thrust over older successions, creating an extensive tectonic outlier or *klippe,* known as the 'St Mellion Klippe' (Figure 10.2). Interleaved within the Crocadon Formation are several large sedimentary blocks up to 1 km in length that appear to bear no structural or stratigraphical continuity with the sandstone–shale sequence. Two such blocks are partially exposed at the quarry.

The first of these is a cherry development comprising at least 5 m of well-bedded, blocky chert and siliceous shale. It forms the major face of the quarry (Figure 10.13) but trenching in the vicinity indicates that the block is about 100 m long and perhaps a little thicker than presently seen in the quarry face. The cherts are thinly bedded (< 10 cm), strongly jointed and dark in colour, although weathered surfaces have a distinctive creamy-yellow coloration, particularly along fractures and minor joints. Thin siliceous shale partings are common and the bedding is essentially horizontal with locally steepened zones close to minor faults.

Some 2 m above the western end of the quarry floor, several thin (5 cm) beds of siliceous shale with finely micaceous parting surfaces yield abundant moulds of conodonts (Matthews, 1969). This fossiliferous interval is only about 20 cm thick and it occurs at about the mid-point of the exposed succession which is generally devoid of conodonts. Representatives of the long-ranging genera *Bryantodus, Ligonodina* and *Lonchodina* dominate the assemblage but more significant are moulds of delicately preserved platform elements that are studied as latex casts. They include *Doliognathus lata, Gnathodus delicatus, Gn. punctatus, Gn. texanus, Hindeodella segaformis, Palmatolepis gonioclymeniae, Pa. gracilis gracilis, Pa. perlobata schindewolfi, Pa. rugosa trachytera, Polygnathus communis, Pseudopolygnathus triangulus pinnatus, Ps. tr. triangulus, Scaliognathus anchoralis* and *Siphonodella obsoleta.*

This assemblage is closely comparable with the *anchoralis*-Zone faunas described by Voges (1959) from the German Sauerland. It includes several species that are regarded as indices of that zone and provides a late Courceyan–Chadian age for the middle part of the chert unit (Figure 10.3). The assemblage also includes older (Upper Devonian) palmatolepid forms.

Part of the second sedimentary block is exposed at the eastern end of the quarry where a thin sliver (0.75 m) of pink and buff shale is juxtaposed above the highest chert bed, some 3 m above the conodont-bearing horizon. This distinctive lithology has been recorded in temporary excavations for several hundred metres away from the quarry (Whiteley, 1981) and is mappable locally as the Bealbury Formation (Figure 10.2). It contains a diverse fauna of entomozoid ostracodes, conodonts, trilobites and ammonoids that clearly indicate an Upper Devonian (late Famennian) age.

Interpretation

Reid *et al.* (1911) mapped the Viverdon Down area before concluding that low-angle faulting probably contributed to the observed structural complexity. This theme was developed by Matthews (1966b), who noted that much of the Carboniferous succession was inverted and associated with detached *klippen* of chert. On the basis of more extensive mapping it now appears that the entire Crocadon Formation represents a sand-rich, shallow-water facies that has been thrust northwards into its present position (Whiteley, 1983, 1984). The isolated blocks of chert (unnamed) and shale (Bealbury Formation) may be interpreted as sedimentary olistoliths that were incorporated into the Crocadon Formation by gravitational sliding at the time of deposition (Selwood *et al.,* 1998).

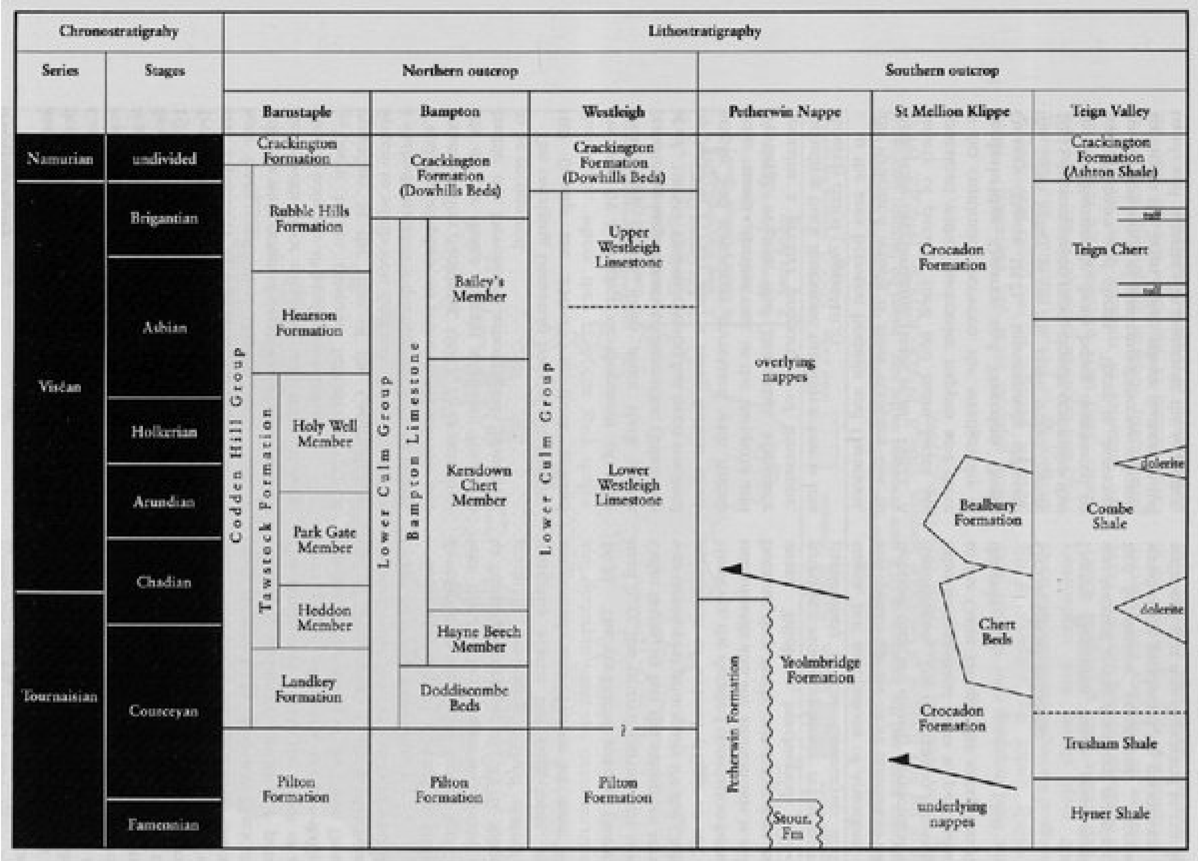
Within a few kilometres of Viverdon Down Quarry, other chert blocks have been recognized at Amytree [SX 362 667] and Smeaton [SX 400 673]. Their lithologies are very similar and a meagre conodont fauna at Amytree confirms their age-equivalence. As the cherts were deposited at about Tournaisian–Viséan boundary times and they show no evidence of soft-sediment deformation, they must have been lithified and emplaced within the Crocadon Formation during late Viséan times. One possible scenario is that syn-orogenic Crocadon sandstones prograded into the precursor basin, incorporating lithified blocks of chert and shale derived from active submarine fault-scarps (Selwood *et al.,* 1998). Another explanation is that the interleaving of these varied lithologies is the result of local thrusting within the St Mellion Klippe.

Apart from providing information about the age of the cherts, the Viverdon Down conodont fauna contributes to the debate about how characteristically Upper Devonian palmatolepids co-exist with indigenous Lower Carboniferous forms. Matthews (1969) was concerned to address this situation having observed that it was also a feature of several *anchoralis-Zone* assemblages in Germany (Voges, 1959; Krebs, 1963, 1964). Matthews considered, and then dismissed, the possibilities of either extending the ranges of palmatolepids into the Carboniferous Period or accepting that the younger occurrences were regenerated homeomorphs. Instead he concluded that reworking was the most likely explanation for the mixed faunas, although he could find no supporting evidence within the uniformly fine-grained cherts themselves. The implications are that very subtle physical processes operating in starved sequences may rework conodonts and no major uplift or emergence within the basin need be invoked.

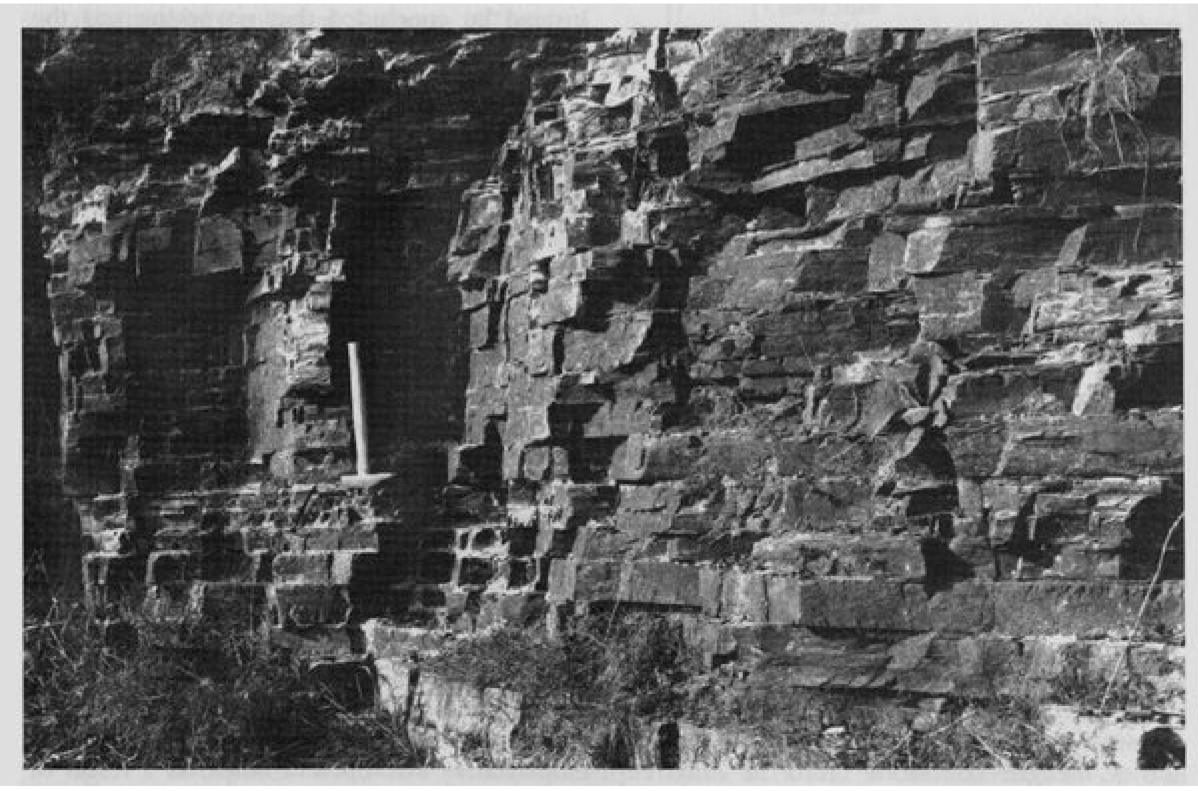
Conclusions

This site is valuable in many respects. The cherts yield a rich conodont fauna that facilitates comparison between similar sequences in the Crocadon Formation and elsewhere in the Culm Trough. Many of the same conodont species also occur in the Lower Carboniferous successions of Germany, confirming the widespread nature of the distinctive chert facies. Despite the fact that the cherts appear undisturbed at Viverdon Down Quarry, their abrupt juxtaposition with the shallow-water sandstones of the Crocadon Formation indicates that they were emplaced as a competent block, as a result of either gravity sliding or thrusting.

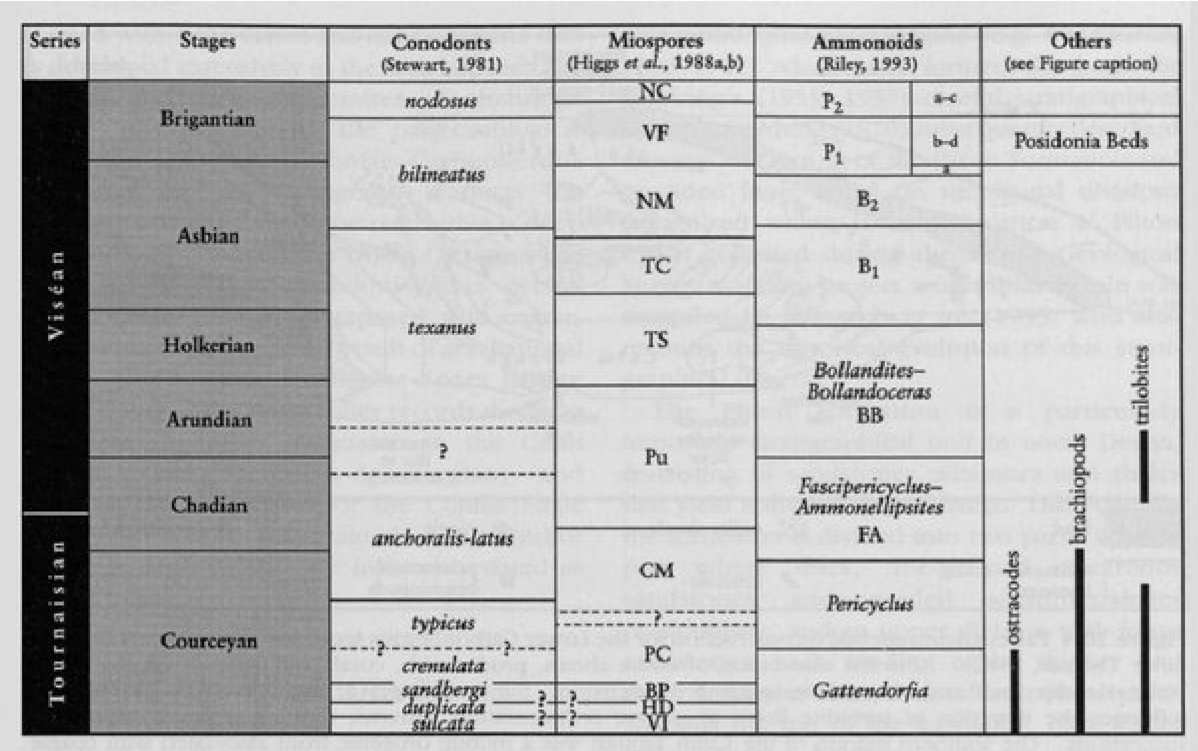
References



(Figure 10.2) Simplified stratigraphical chart for the Lower Carboniferous strata of the Culm Trough. Compilation based on information from Seiwood and Thomas (1987), Jackson (1991) and Owens and Tilsley (1995). Much of the stratigraphical nomenclature in the CuIm Trough is informal and is reproduced here according to common usage. The aim is to summarize a range of differing successions rather than imply that the rock units are well dated and have isochronous boundaries. Note that the Chert Beds and the Bealbury Formation in the Crocadon Formation of the St Mellion Klippe may be olistoliths or isolated thrust-bound units; see Viverdon Down Quarry GCR site report (this chapter) for further details. Half-arrows represent thrust faults. Stour. Fm — Stourscombe Formation. Not to scale.



(Figure 10.13) Thinly bedded Viséan cherts with fine shale partings, Viverdon Down Quarry, east Cornwall. (Photo: J. Jones.)



(Figure 10.3) Biostratigraphical schemes for the Lower Carboniferous strata in the Culm Trough based on conodonts, miospores and ammonoids. The distribution of other useful fossil groups is also shown; entomozoid ostracodes are locally abundant in the Courceyan Stage (Selwood et al., 1982; Gooday, 1983), as are diverse trilobite and brachiopod faunas (Goldring, 1955, 1970). Trilobites are more sporadic in the Chadian (Owens and Tilsley, 1995) and younger stages (Prentice, 1967) but the concurrence of Posidonia becheri and Neoglyphioceras spirale is a common feature within the early Brigantian Posidonia Beds (Thomas, 1982; Riley, 1993).