Park Gate Quarry, Devon

[SS 557 297]

Introduction

The Park Gate Quarry GCR site is a disused quarry in the crest of the hill at Tawstock [SS 557 297], near Barnstaple (Figure 10.1). It exposes the middle part of the Dinantian Codden Hill Group, which is widely developed in north Devon. The site is particularly important because it is the stratotype for the chert-dominated Tawstock Formation, formerly part of the Codden Hill cherts recognized by Phillips (1841). Beds within the Tawstock Formation contain a rich and varied macrofauna that includes trilobites, ammonoids, brachiopods, corals and crinoids of late Chadian age. The most useful stratigraphical accounts of this locality are provided by Edmonds *et al.* (1985) and Jackson (1991); the faunas have been described by many authors, notably Prentice (1960) and Owens and Tilsley (1995).

Description

Near-vertical bedding planes form the prominent northern face of this quarry but the rather degraded dip-section along the eastern flank provides the most stratigraphical information. Jackson (1991) nominated this site as the stratotype for the Tawstock Formation (Figure 10.2), a mappable unit of siliceous mudstones and cherts, but noted that no single exposure provided a complete sequence through the formation, which is estimated to be 125 m thick.

The lowest beds at Park Gate comprise some 12 m of dark, laminated siliceous mudstones that occasionally include large wood fragments and show some evidence of bioturbation. They are overlain by 15 m of pale-weathering, siliceous mudstones with a distinctive platy fracture and a porous, open texture that suggests they were originally calcareous. Fossils are common within this interval; trilobites and crinoids are often finely preserved as moulds in deeply weathered, partially silicified limestones, whereas the ammonoids are usually found crushed on bedding planes. Above the pale fossiliferous beds, a further 18 m of alternating pale and dark mudstones are exposed, the unit becoming increasingly indurated as thin (5–10 cm) dark-grey, siliceous mudstones predominate. In total, some 45 m of succession is exposed, and Jackson (1991) regards it as sufficiently distinctive to be called the 'Park Gate Member' of the Tawstock Formation (Figure 10.7).

Above the Park Gate Member, several metres of poorly exposed, uniformly dark siliceous mudstones and blocky cherts occur. They are interbedded with thin shale partings at about 5 cm intervals and commonly include phosphatic nodules. Abundant, well-preserved radiolarians tend to be concentrated into discrete bands or laminae but otherwise no useful fossils have been found. Jackson (1991) considers this succession to form part of the Holy Well Member, the uppermost of three members that comprise the Tawstock Formation (Figure 10.7).

Prentice (1960) first described the macrofossils from this site following his discovery of a richly fossiliferous horizon (Bed X) in the pale-weathering mudstones of the Park Gate Member. This horizon, and loose material from the scree below, yielded a rich fauna dominated by trilobites, ammonoids, brachiopods and corals. Prentice's original material has been the subject of much discussion and taxonomic revision (see Owens and Tilsley, 1995 and references therein), particularly with respect to the assemblage of phillipsiid trilobites.

As a result of extensive new collections made between 1988 and 1992, Owens and Tilsley (1995) recorded the following trilobite taxa from Park Gate: *Aprathia kobele, Archegonus* '*Philibole*' *habena, Liobole glabra Proxima, Liobole* aff. *glabroides, Spatulina spatulata, Tawstockia longispina* and *Wagnerispina coddonensis.*

These species are either small-eyed or blind, with relatively thin and unornamented cuticles.

Associated ammonoids, including *Ammonellipsites, Eonomismoceras* and *Merocanites,* have been described by Prentice (1960) and dated as late Chadian age by Riley (in Edmonds *et al.* 1985). Rather unusually, they co-exist with a

coral–brachiopod fauna that includes *Cladochonus michelini* and small chonetoids such as *Lissochonetes* cf. *laguessianus, Pliochonetes buchianus* and *Tornquistia polita.*

Interpretation

The debate about the age of the cherts in north Devon and their position within the Culm succession has continued for more than a century. Phillips (1841) noted that the Codden Hill cherts were associated with limestones containing the bivalve *Posidonia*; Hinde and Fox (1895) produced the first comprehensive account of their fauna and microscopic characteristics. Prentice (1960) provided an interesting historical perspective of that pioneering period and added much valuable palaeontological information from the area around Barnstaple. However, it was not until systematic field mapping of the entire region had been undertaken (Edmonds *et al.,* 1985) that a clear stratigraphical picture emerged. This established a shale-dominated Lower Carboniferous succession about 250 m thick, typically with a thickly developed and widespread chert unit in the middle part of the succession.

Further palaeontological work, integrated with field data, allowed Jackson (1991) to divide the long-established Codden Hill Group into a more formal stratigraphy based on local type sections. Of the formations defined, the Tawstock Formation is further subdivided into three members, as illustrated in (Figure 10.7). The Heddon Member (*c.* 40 m) is characterized by black siliceous mudstones and shales whilst the overlying Park Gate Member (*c.* 70 m) is predominantly paler and includes a moderately diverse fauna. It is the upper 45 m of this member that is exposed at Park Gate and, as that constitutes the most complete succession in the area, it provides the designated stratotype (Jackson, 1991). The Holy Well Member (*c.* 15 m) is poorly exposed and much faulted but includes highly siliceous black cherts. Whether this stratigraphical refinement proves to be durable remains to be seen, but it provides some context in which to consider the palaeoenvironmental and biostratigraphical value of the Park Gate trilobite fauna.

Owens and Tilsley (1995) noted that the trilobites are all either blind, or have eyes that are reduced to a small number of lenses. This is a feature common to other Dinantian taxa that are adapted to deeper water environments such as the Craven Basin of north-west England (see River Hodder GCR site report, Chapter 6) and the German Rhineland. Despite this similarity, there is little correspondence between these assemblages at the generic level, probably because of differences in age and substrate.

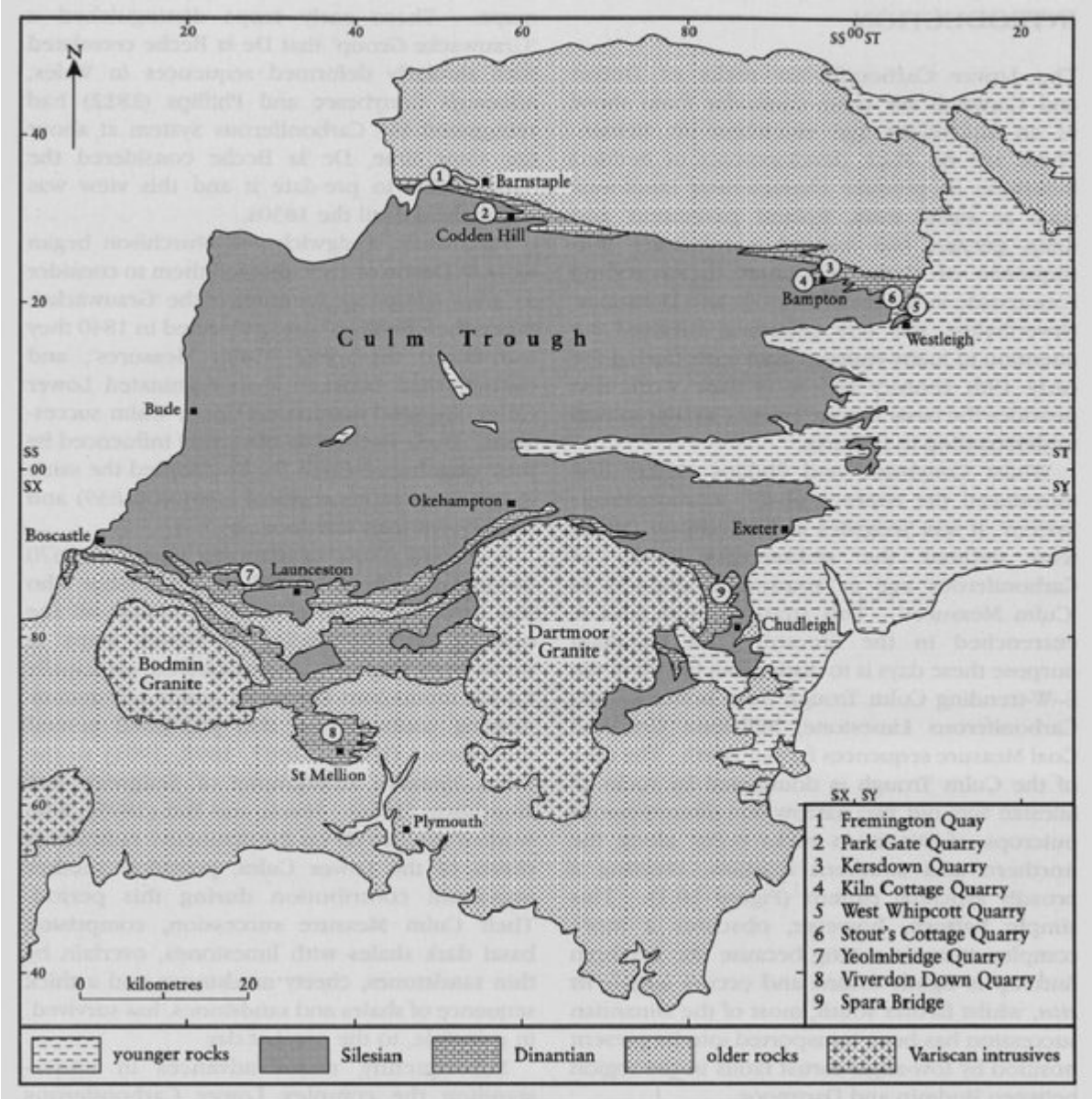
However, *Archegonus babena* and *Liobole glabra proxima* are known from the Brezina shales of Moravia in the Czech Republic, which are correlated with the German cully ammonoid zone (Chlupic, 1966). This is consistent with the late Chadian age indicated by the ammonoids that Riley (1991) ascribes to the late FA ammonoid zone (Figure 10.3).

The origin of the bedded chert sequence at Park Gate Quarry, in common with equivalent facies elsewhere in the Culm Trough, is subject to several interpretations. These include re-deposition of siliceous pelagic sediments by turbidity currents and biogenic segregation of initially homogeneous siliceous muds into silica-rich cherts and silica-poor mudstones. Such interpretations generally imply a deep-water origin although, as noted by Hesse (1988), shallow-water cherts are not unknown in the geological record.

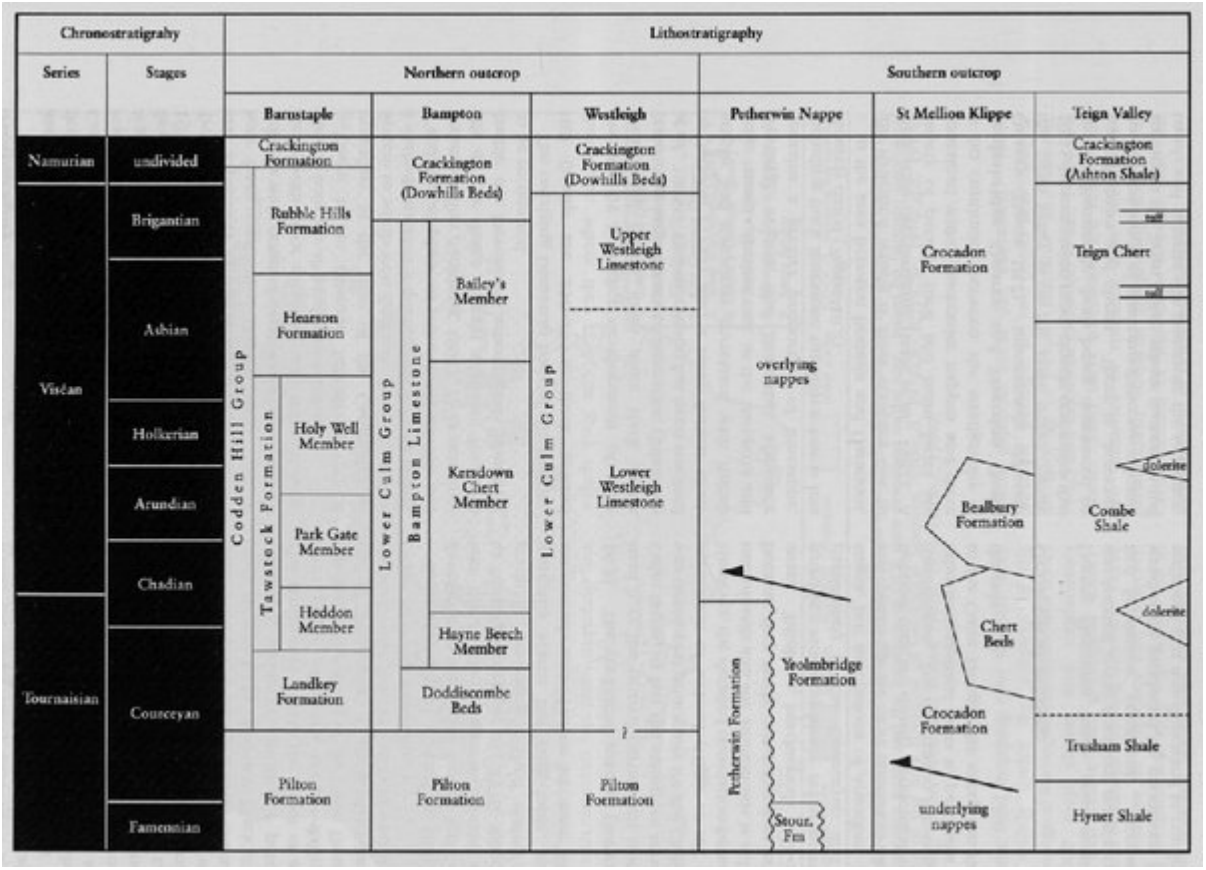
Conclusions

This classic locality is of national importance and it has contributed significantly to the understanding of Dinantian stratigraphy in north Devon. It provides the stratotype for both the Tawstock Formation and one of its components, the Park Gate Member. The well-preserved trilobites facilitate valuable taxonomic and palaeoenvironmental studies, whilst the ammonoids provide information about the age of the cherts. Together, the fossils help to establish correlation links with other areas in Britain and northern Europe.

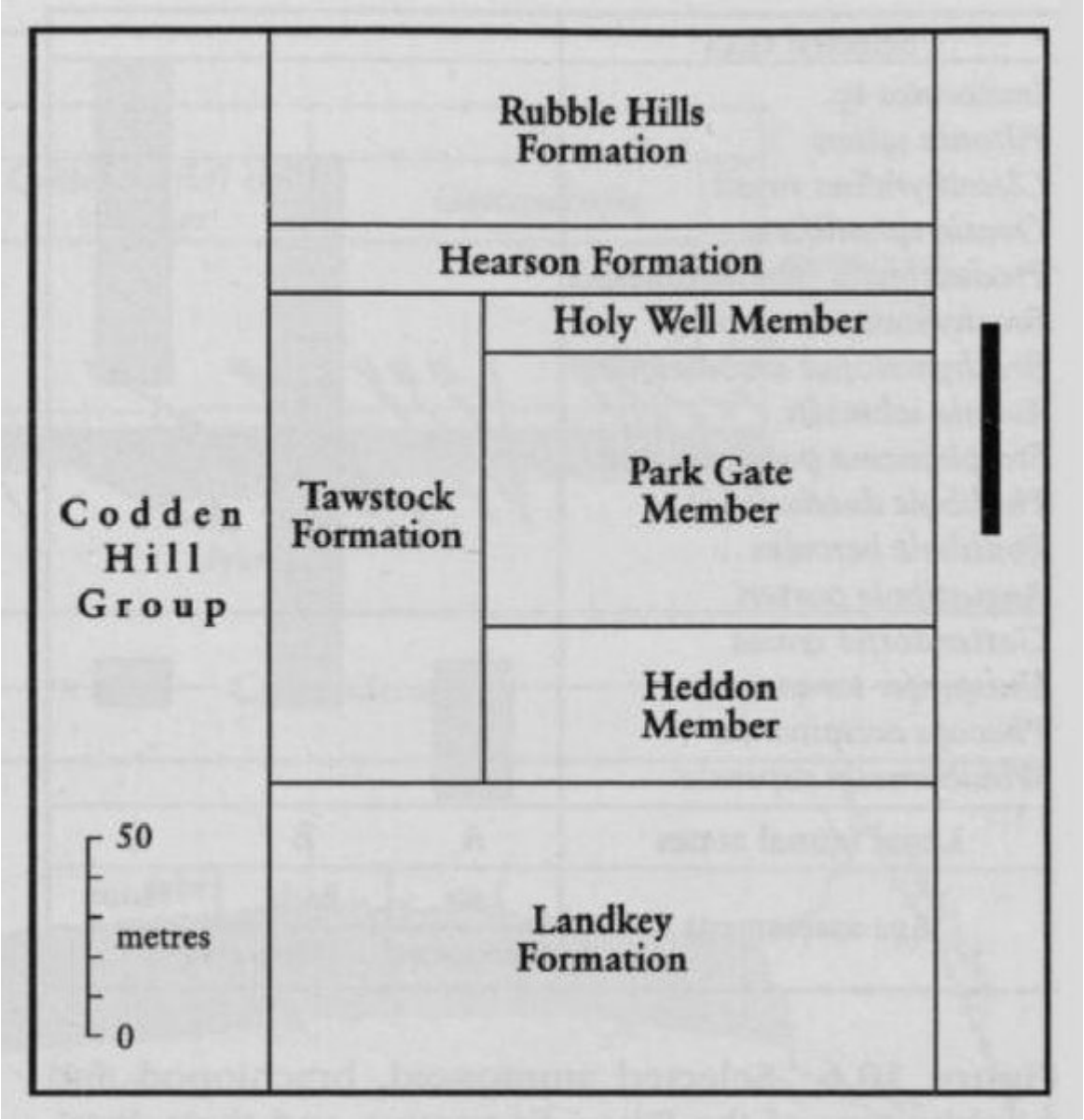
References



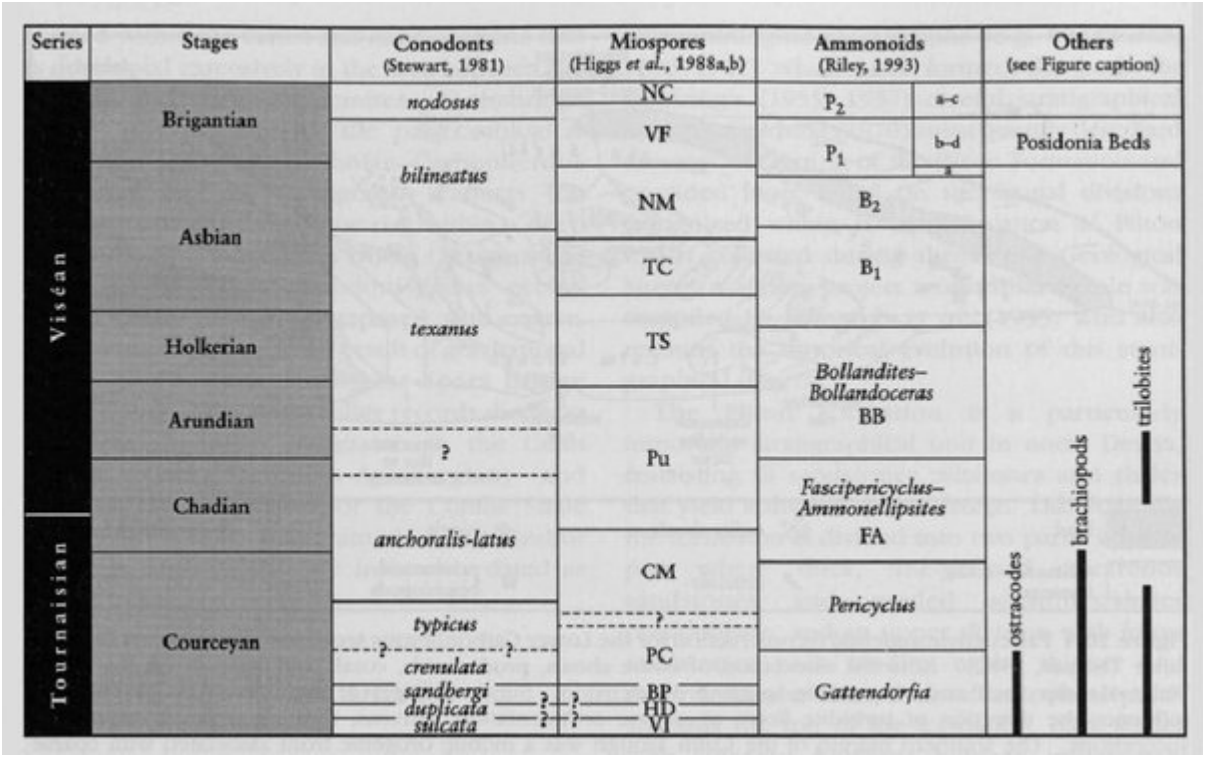
(Figure 10.1) Simplified geological map of central south-west England showing the northern and southern outcrops of Dinantian strata and the locations of GCR sites described in the text. Based on [British] Geological Survey maps of the area (Institute of Geological Sciences, 1969c,d, 1974a,b,c,d, 1975c, 1976c,d,e, 1977d, 1980a,b, 1982; British Geological Survey, 1993b, 1994, 1995b,c, 1998).



(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 10.7) Lithostratigraphical subdivisions of the Codden Hill Group, north Devon (after Jackson, 1991). The extent of the Tawstock Formation at Park Gate Quarry is indicated by a vertical bar in the right hand column.



(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).