Chapter 3 Culm Trough

There are about 3500 km^2 of Upper Carboniferous surface outcrop in north Cornwall, Devon and west Somerset, mainly in an area between Barnstaple and Bampton in the north, and Boscastle and Exeter in the south (Figure 3.1). The coastal exposures are particularly fine and have revealed exceptional stratigraphical and structural detail.

The Upper Carboniferous of this area consists mainly of marine or marginal marine deposits, quite different from the fluvio-deltaic sequences present in the rest of Britain. They are widely referred to as the Culm deposits, following Sedgwick and Murchison (1840), a term apparently referring to the thin, sooty coal seams that they contain (although Edmonds *et al.,* 1975 suggest a possible origin in the Welsh word 'cwlwm' (knot) referring to the contorted nature of the strata). These coals are generally of poor quality and are mainly restricted to a narrow belt between Greencliff on the coast near Bideford, to Hawkridge Wood near Chittlehampton. Despite their poor quality and tectonic disturbance, they were worked at least as far back as the Middle Ages and as recently as 1969 (Edmonds *et al.,* 1979). As well as a fuel, they were used as a pigment for black paint (hence the name of one of the principal coals, the Paint Seam).

History of research

Edmonds (1974) and Edmonds *et al.* (1975) discuss the history of research on these strata. The groundwork was done by Conybeare (1814, 1823), De la Beche (1834, 1839), Sedgwick and Murchison (1840) and, perhaps most significantly, Ussher (1881, 1887, 1892, 1900, 1901). Subsequent work by Arber (1907, 1911), Owen (1934, 1950) and Prentice (1960a, 1960b, 1962), culminated in a series of sheet memoirs by the British Geological Survey, which provide the most detailed accounts of the geology of this area (e.g. Freshney *et al.,* 1972, 1979; McKeown *et al.,* 1973; Edmonds *et al.,* 1979, 1985).

The Upper Carboniferous of Devon and Cornwall is not particularly rich in fossils, but intensive work mainly by Arber (1904), Rogers and Arber (1904) and Rogers (1909, 1910) provided enough material to establish the main details of the biostratigraphy (more recent data are reviewed by House and Selwood, 1966, Freshney and Taylor, 1972 and Edmonds, 1974). The most recent study is by Eagar and Xu (1993) on the bivalves of the Bideford Formation exposed on the Abbotsham coast.

Most recently, attention has turned to the sedimentology of these strata (Reading, 1963, 1965, 1971; Walker, 1964a; De Raaf *et al.,* 1965; Lovell, 1965; Burne, 1969, 1970; Higgs, 1984). From this work, it has been possible to build up a comprehensive history of the development of the Culm Trough, much of which is usefully summarized by Thomas (1982, 1988).

Lithostratigraphy

Being so different from the coeval strata found in the rest of Britain, the Upper Carboniferous of the Culm Trough is placed in the Culm Group. A number of different formations have been proposed for these strata, but the tripartite scheme established by Edmonds (1974) for use throughout the trough is now generally accepted. The three formations may be summarized as follows (largely based on Thomas, 1988).

Crackington Formation

Stratotype: Widemouth to Crackington Coast

Base defined: top of uppermost chert or impure detrital limestone in Culm Group.

Characteristic facies: quartz-dominated, fine to medium grained (turbiditic) sandstones, interbedded with at least equal thicknesses of marine mudstones and shales.

Chronostratigraphical range: Arnsbergian to lower Langsettian.

Bideford Formation

Stratotype: Abbotsham Coast

Base defined: Mermaid's Pool Sandstone

Characteristic facies: medium-scale coarsening-upwards cycles, with black shales at the base, grading up through a range of siltstones and sandstones, and topped by a thick feldspathic, cross-bedded sandstone.

Chronostratigraphical range: (?)Yeadonian to lower Langsettian.

Bude Formation

Stratotype: Bude Coast

Base defined: top of Hartland Quay Shale

Characteristic facies: mainly dark shales with thin sandstone and siltstone ribs, but also with major structureless sandstone units, often with mudstone clasts.

Chronostratigraphical range: lower Langsettian to Bolsovian.

The spatial relationship between the three formations is summarized in (Figure 3.2). From this, it is evident that the Bideford Formation is a localized deposit, a lateral equivalent partly of the upper Crackington Formation and partly the lower Bude Formation.

Geological setting

The Culm Group is the infill of an east–west trending marine trough — the Culm Trough. In the Early Carboniferous, deep water sediments predominate (Goldring, 1962), except in the south, where there are various paralic, shelf and basin deposits (Selwood *et al.,* 1984; Selwood and Thomas, 1986; Turner, 1986). During the Namurian, however, uplift of neighbouring land, probably as a result of the northwards progression of the Variscan Front, caused an inflow of turbidites (Crackington Formation) into the trough. By the end of the Namurian, the marine trough had become effectively filled and subsequent sedimentation was essentially brackish to fluvio-deltaic, with only occasional brief marine interludes (Bideford and Bude formations). Deposition was eventually terminated by Variscan uplift, probably sometime in the late Westphalian (post early Bolsovian).

Palaeocurrents suggest that the turbiditic infill of the Culm Trough was derived from somewhere in the present-day Bristol Channel. Owen (1971e), Kelling (1974) and Cope and Bassett (1987) have postulated a landmass there (named 'Sabrina' by Kelling), supplying sediment to both the Culm Trough and the South Wales basin. It has been questioned whether such an apparently narrow feature could have supplied the quantity of sediment that is now found in those areas (e.g. Higgs, 1986). However, Kelling (1974) has argued that the Bristol Channel landmass was significantly larger than is indicated by the present distance between Devon and South Wales, and that it was subject to considerable crustal shortening, indicated by major Variscan folds and thrusts.

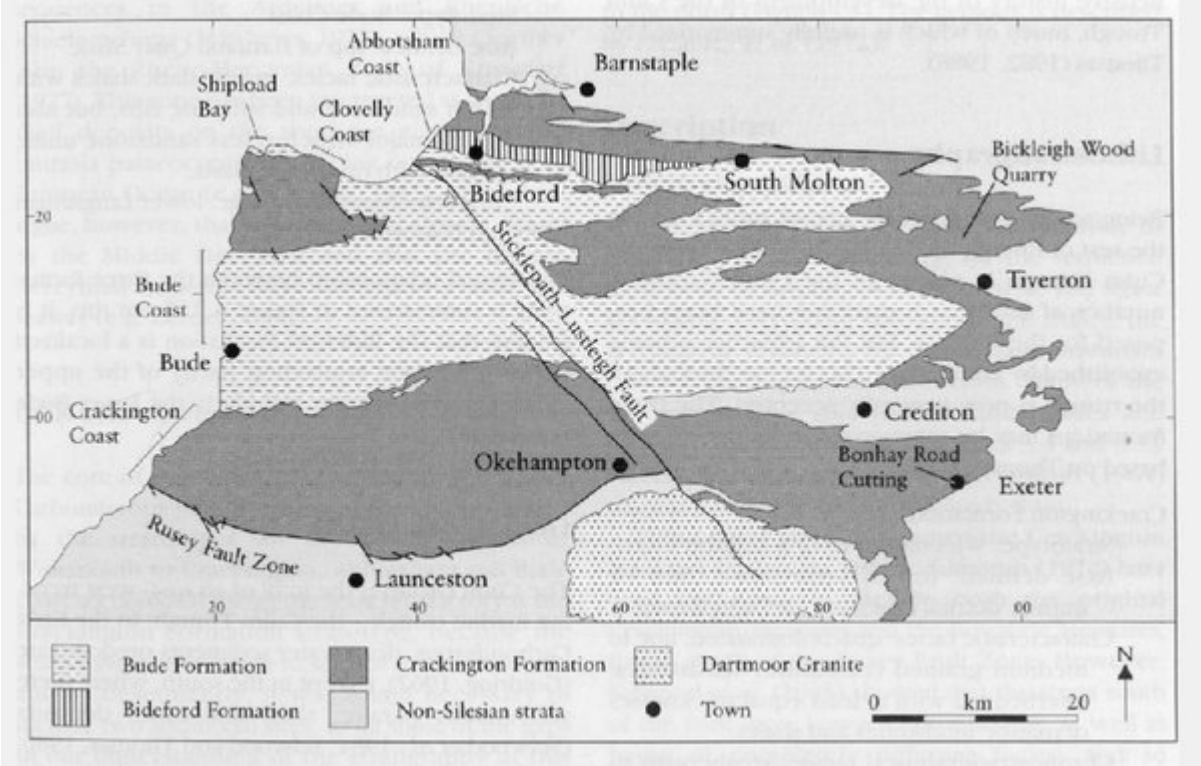
The Culm Group is best compared with sequences in the Ardennes and Rhenische Schiefergebirge (Matthews, 1977), which together form the Rheno-Hercynian Zone of Kossmatt (1927). This zone has been interpreted as a suite of shelf deposits on the southern margin of the Laurasia palaeocontinent, facing out on the Mid-European Ocean (e.g. Johnson, 1981). Many now argue, however, that this ocean had already closed by the Middle Devonian and that the Rheno-Hercynian deposits were formed in a back arc seaway (e.g. Leeder, 1988).

GCR site coverage

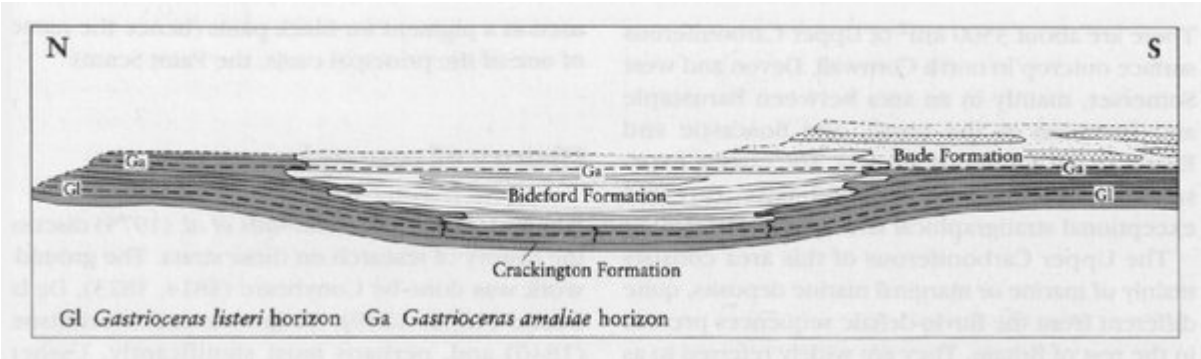
The core of the GCR site coverage for the Upper Carboniferous part of the Culm Group is provided by the stratotypes for the three formations: Widemouth to Crackington, Abbotsham and Bude coast sections. Of these, the least satisfactory is the Crackington Formation stratotype, because the strata have been subject to serious tectonic disturbance. Consequently, it was found necessary to include two additional sites, to fill some of the gaps in our understanding of the stratigraphy of this formation: Bonhay Road Cutting for the Alportian and possibly Arnsbergian, and Clovelly Coast for the Yeadonian to Langsettian. The Bonhay exposure is also of interest in that it apparently reveals a deeper water succession than in the stratotype.

In addition to these major sections, two other sites have been included on essentially sedimentological grounds: Bickleigh Wood Quarry for showing characteristic turbiditic features in the Crackington Formation, and Shipload Bay for shallow water sedimentary structures in the Bude Formation.

References



(Figure 3.1) Map of parts of Devon and north Cornwall, showing the distribution of Upper Carboniferous deposits. Based on Thomas (1988, fig. 4.2).



(Figure 3.2) Relationship between the Crackington, Bideford and Bude formations in southwest England. Based on Edmonds et al. (1979, fig. 8).