

---

## Chapter 2 Introduction to Cambrian stratigraphy

A.W.A. Rushton

### History

The founding of the Cambrian System and the subsequent modifications that it underwent have been recounted several times (Stubblefield, 1956; Holland, 1974) and the controversy over the upper limit of the system that led to the founding of the Ordovician was described in detail by Secord (1986). In summary, the name Cambrian was first applied by Sedgwick to a large assemblage of rocks in North Wales, encompassing outcrops from the island of Anglesey and Snowdonia to Bala and the Berwyn Hills (Sedgwick and Murchison, 1835). At that time both he and Murchison — who had already proposed the Silurian System, mainly for rocks in the Welsh Borderlands and South Wales (Murchison, 1835) — supposed that the Silurian overlay the Cambrian. Only later did it become apparent that there was major overlap between these stratigraphical systems. Although Sedgwick himself subsequently excluded the older (now Precambrian) rocks from his Cambrian System, he disagreed with Murchison as to what level should be taken as the upper boundary of the Cambrian. Secord (1986) tells how those workers' early co-operation turned into a bitter controversy that was resolved only after the death of both combatants — when Lapworth (1879a) argued for a tripartite division of the Lower Palaeozoic and proposed that the greater part of the disputed strata should form the basis of a new system, which he named Ordovician. Lapworth's suggestion steadily gained acceptance in Britain, and subsequently elsewhere. The international adoption of the Cambrian System and the formalization of the lower, middle and upper divisions with something like their present usage owe much to the advocacy of Walcott (Yochelson, 1993, p. 119).

### Distribution

The Cambrian rocks of Britain occupy a relatively small area (Figure 1.1). They were reviewed by Rushton (1974) and Cowie (1974) and their correlation was discussed by Cowie *et al.* (1972). The largest outcrops are in Wales, where they represent thick sedimentary accumulations (the greater part of the Dyfed Supergroup of Woodcock, 1990) that formed during an early phase of the development of the Welsh Basin. The best representation of the Cambrian System in the historical type area of North Wales is in the Harlech Dome (see (Figure 3.2)), together with the similar sequence as exposed in the small but important outlying area of St Tudwal's Peninsula (see (Figure 3.3)). In neither of these outcrops is the base of the Cambrian seen. The Arfon area to the north-west, which lies close to Anglesey and the Irish Sea Horst complex, presents a less complete sequence in which the Comley Series differs strikingly from that of the Harlech Dome (see (Figure 3.1)). The contact with the Precambrian there has been claimed as both conformable and unconformable. The Cambrian sites of North Wales are described in Chapter 3. The main area of Cambrian rocks in South Wales (Chapter 4) is in the west, around St David's (see (Figure 4.2)). The recently described succession in the small area at Llangynog (Figure 2.1) differs from that at St David's (Cope and Rushton, 1992; Cope and McIlroy, 1998), but no Cambrian GCR sites have been selected for the aforementioned area at the present time.

In the Cambrian of England (see Chapter 5), shelf deposits of the Midland Platform form thinner sequences, which are exposed in small inliers. They display two main facies: the rocks near the western edge, exposed in the Comley and Wrekin areas of Shropshire and in the Malvern Hills (Figure 2.1), show discontinuous deposition (see (Figure 4.1)) in shallow water. In contrast, the succession over the central part of the Midland Platform, exposed in the Nuneaton area and proved in boreholes over a wider area, was deposited more continuously in deeper water.

In northern Scotland the Cambrian of the Hebridean Terrane foreland comprises the greater part of the shallow-water succession that crops out in a narrow belt nearly 200 km long (see Chapter 12). The possible presence of Cambrian rocks farther to the south, in the Dalradian Supergroup and the Highland Border complex, was discussed by Cowie *et al.* (1972) and was generally discounted by Brasier *et al.* (1992h), with the exception of the Leny Limestone: this is satisfactorily dated as Cambrian but its stratigraphical relationships are contentious. It has a very small outcrop close to the Highland Boundary Fault Complex and has been considered to be part of the Highland Border Complex, but it is

alternatively regarded as part of the Dalradian succession (Tanner, 1995; Molyneux, 1998). It is discussed in Chapter 13.

## Boundaries of the Cambrian System

Views on both the lower and upper boundaries of the Cambrian have varied. Earlier opinions on British rocks were reviewed by Stubblefield (1956).

### Lower boundary

Because most of the British Cambrian rocks occur in association with uplifted Precambrian rocks, historically it proved convenient to take the base of the Cambrian at the widespread unconformity between proven Cambrian and the presumed Precambrian below, though in certain places, where no such unconformity was clearly evident, controversies developed in the late 19th century as to the extent of the Cambrian and the significance of the Precambrian (see discussion of the Arvon area (Chapter 3) and the St David's area (Chapter 4)).

Extended international discussions to identify a stratotype by which to define the base of the Cambrian have resulted in the selection of a level in the Chapel Island Formation at Fortune Head in south-east Newfoundland (Brasier *et al.*, 1994; Landing, 1994). The level chosen is at the base of the *Phycodes pedum* trace-fossil zone (Figure 2.2) and is thought to have an age of about 543 Ma (Grotzinger *et al.*, 1995). Correlations by Landing (1996) and Conway Morris *et al.* (1998) suggest that this stratotypic base lies at a markedly lower stratigraphical level than British rocks previously regarded as basal Cambrian (Cowie *et al.*, 1972), whilst drawing strata previously regarded as late Precambrian into the Lower Cambrian (Bland and Goldring, 1995; McIlroy *et al.*, 1998).

### Upper boundary

In Britain, the top of the Cambrian was for many years taken at the widespread unconformity between rocks of Tremadoc and Arenig age, as originally indicated by Lapworth (1879a). The Tremadoc outcrop parallels that of the Cambrian throughout Wales and England and was regarded as a natural part of the Cambrian. In continental Europe and North America, faunal considerations allied the equivalents of the Tremadoc with overlying Ordovician strata, the Tremadoc Series being regarded as basal Ordovician — a consideration that Lapworth himself was ready to entertain (in discussion of Groom, 1902, p. 148). The subject was reviewed by Henningsmoen (1973), and following international discussions a level at or close to the base of the Tremadoc was adopted for the Cambrian—Ordovician boundary (see Webby (1998) for a review). A stratotype has been recommended at Green Point, north-west Newfoundland (see Chapter 6), but has still (1999) to be ratified. The level chosen is very close to the base of the Tremadoc Series as proposed by Rushton (1982) at Bryn-llyn-fawr, North Wales. Its age is close to 490 Ma (Davidek *et al.*, 1998), making the duration of the Cambrian just over 50 million years.

## Divisions of the Cambrian

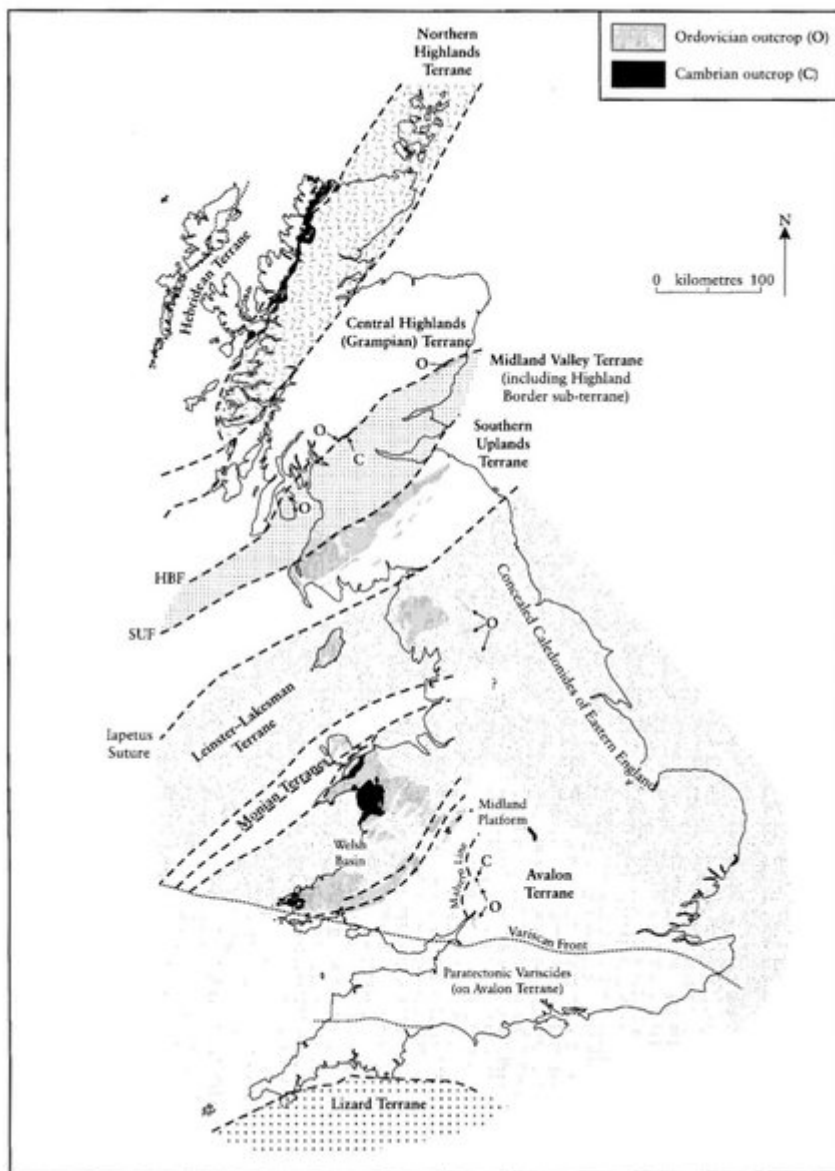
Stage and series divisions of the Cambrian have been employed in a regional sense in many parts of the world, but there is no globally agreed standard. Although the terms 'Lower', 'Middle' and 'Upper' Cambrian are widely used, they have different senses in different regions, as exemplified by Shergold's correlation chart (in Whittington *et al.*, 1997, p. 303). The discrepancies in usage are most marked at the base of the Middle Cambrian. Cowie *et al.* (1972) introduced, but did not formally define, the regional series terms 'Comley', 'St David's' and 'Merioneth', which stabilized respectively the 'Lower', 'Middle' and 'Upper' Cambrian (excluding the Tremadoc), as conventionally used in Britain. These terms, although provisional, are used here to facilitate reference to earlier compilations (Cowie *et al.*, 1972; Rushton, 1974). Harland *et al.* (1982) rejected the term 'Comley Series' because the term 'Comley' is applied also to the Comley Sandstone, and they introduced the term 'Caerfai Series' instead, even though it was open to the same objection, in that the nomenclature is shared with the Caerfai Group (Landing *et al.*, 1989). However, it may be feasible to abandon both of those terms and use instead the terms used for two better-defined series proposed for the Lower Cambrian in Newfoundland (Figure 2.2), namely the 'Placentian' and 'Branchian' (Landing, 1992). The old term, 'Acadian Series', recently revived for the Middle Cambrian as recognized in Newfoundland and New Brunswick (Landing, 1996), has

priority over, and may be more apt than, 'St David's Series', which is of comparable scope. Unfortunately 'Acadian' is also widely used in the context of a Devonian phase of the Caledonian Orogeny, and its revival in a stratigraphical sense may lead to confusion. Therefore 'St David's Series' is retained here. 'Merioneth Series' is also retained, and Landing (1996) has adopted it (as 'Merionethian') for all of Avalonia.

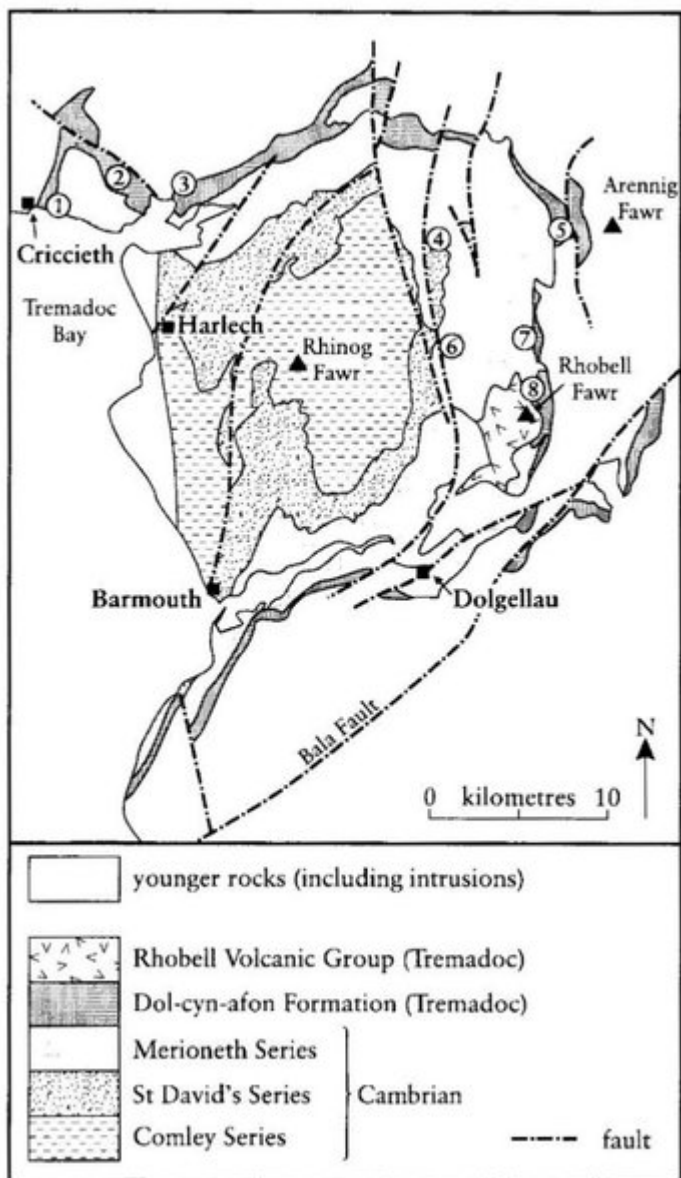
No stages have been formally proposed for British Cambrian rocks. There has been some use of stage-level terms derived from the lithostratigraphically conceived Solva, Menevian, Maentwrog and Dolgellau divisions (Harland *et al.*, 1982), but none of them has yet been defined and their use is to be deprecated. Orłowski (1992) gave approximately the same intervals the informal designations stages C, D, E and F, and suggested that they could be used in Polish, Scandinavian and British stratigraphy.

The zonal scheme shown in (Figure 2.2) is based on that of Cowie *et al.* (1972). The zones of the Comley Series are generalized and due for revision, taking into account more recent work, especially in Newfoundland, as indicated by Brasier (1989; in Brasier *et al.*, 1992b). Those of the St David's Series are based on the Scandinavian succession, which is modified by discarding the *Goniagnostus nathorsti* Zone, as recommended by Berg-Madsen (1985). The Merioneth zones are based on the Scandinavian succession of olenid trilobites. The subdivision of the *Olenus* Zone into four subzones follows Rushton (1983).

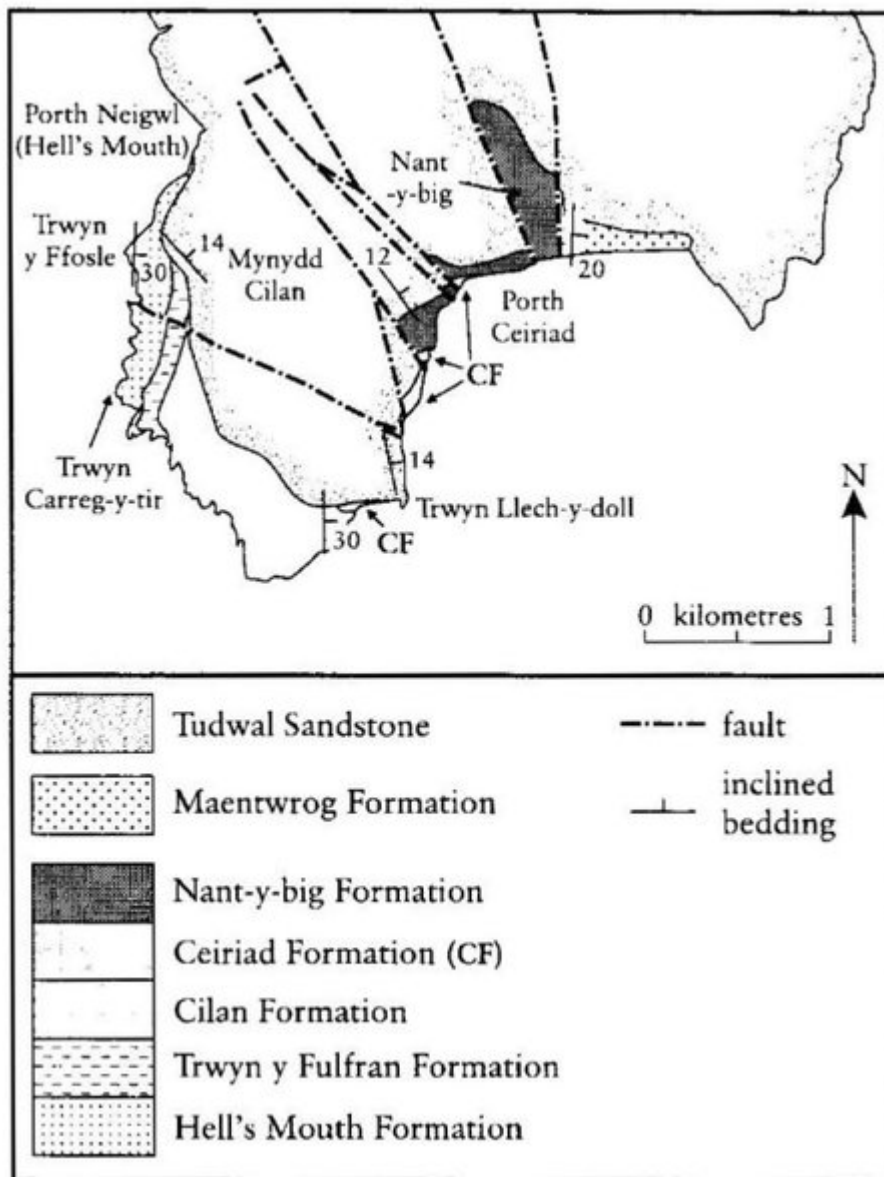
### References



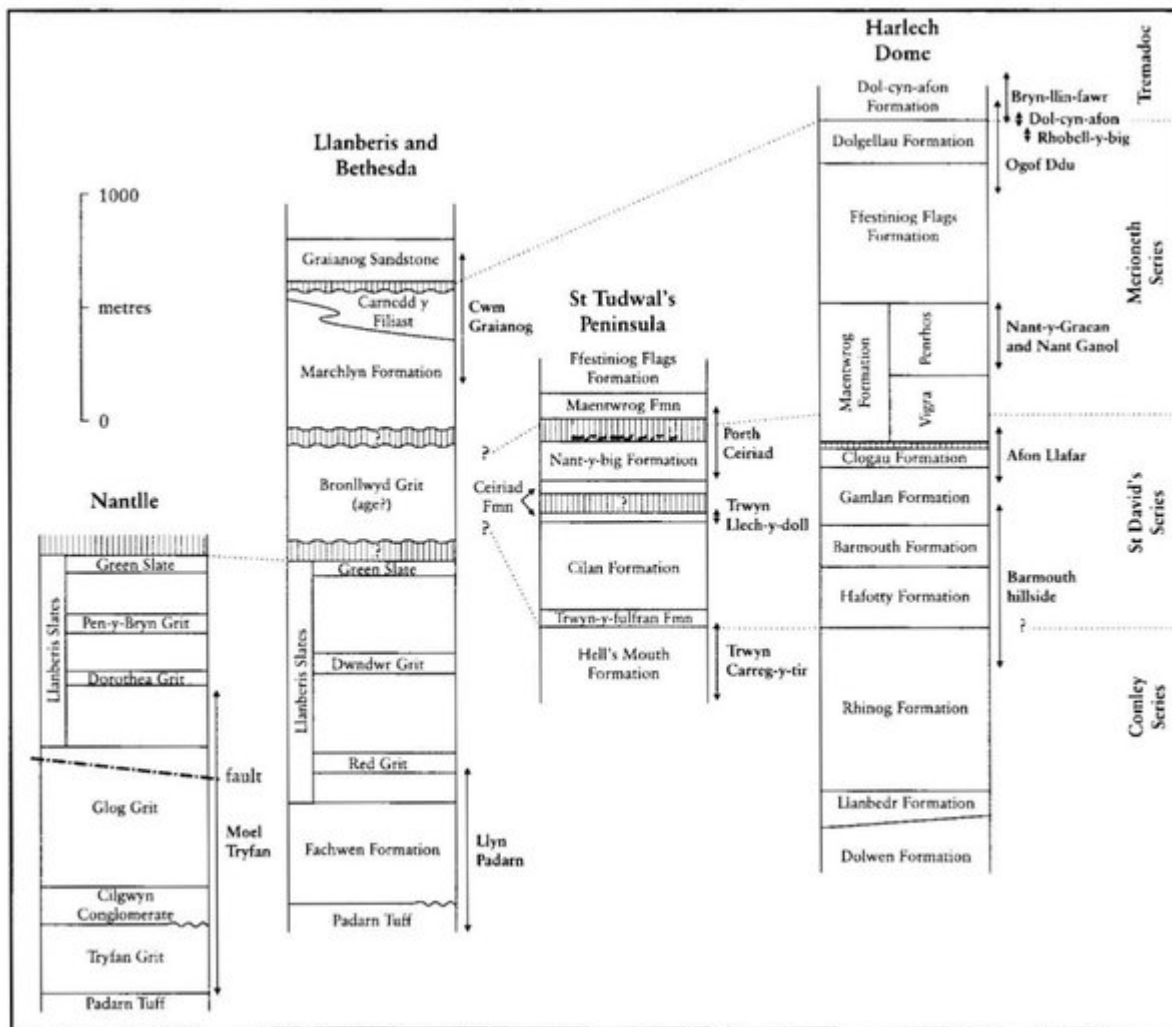
(Figure 1.1) Distribution of Cambrian and Ordovician rocks in the principal terranes in Great Britain, after Bluck *et al.* (1992). HBF, Highland Boundary Fault; SUF, Southern Upland Fault.



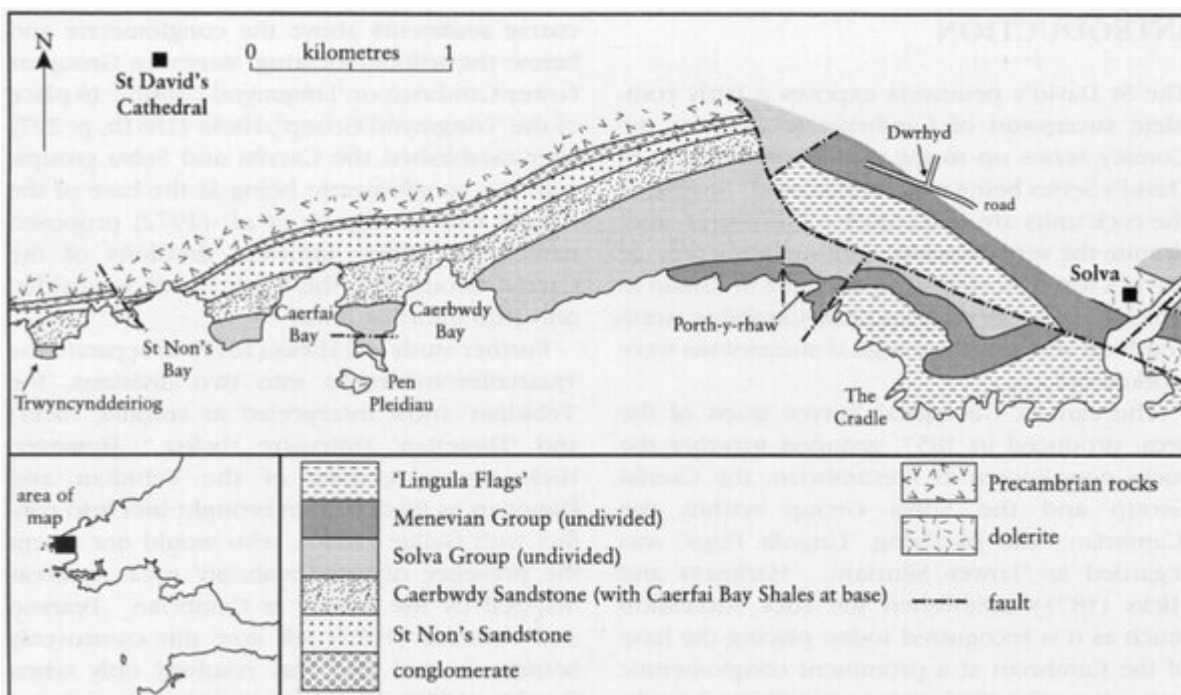
(Figure 3.2) Geological sketch-map of the Harlech Dome, after the British Geological Survey (1994b). Cambrian and Tremadoc GCR sites are as follows: 1, Ogof Ddû; 2, Tyn-Ilan and Wern; 3, Y Garth; 4, Afon Llafar; 5, Amnodd Bwll; 6, Nant-y-graeon; 7, Bryn-Ilin-fawr; 8, Rhobell-y-big and Dol-cyn-afon.



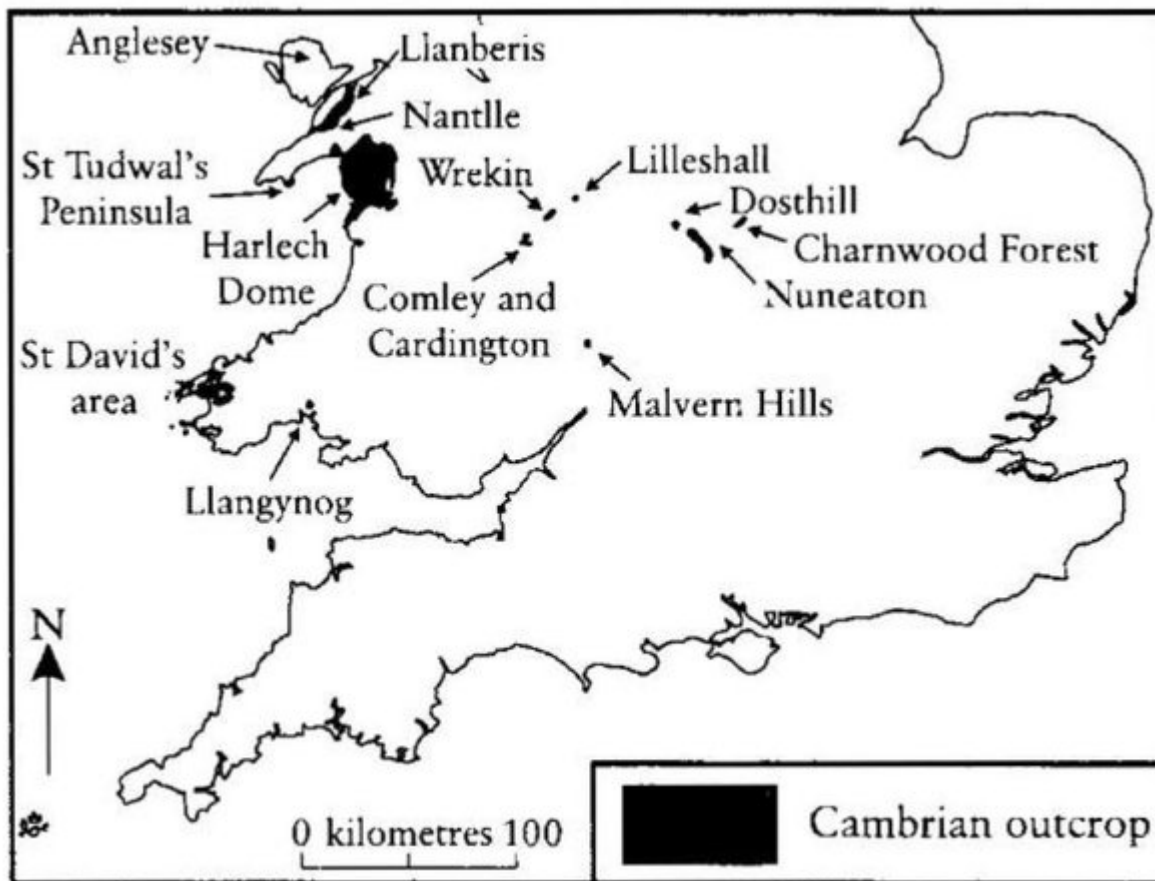
(Figure 3.3) Geological map of St Tudwal's Peninsula, after Nicholas (1915) and Young et al. (1994).



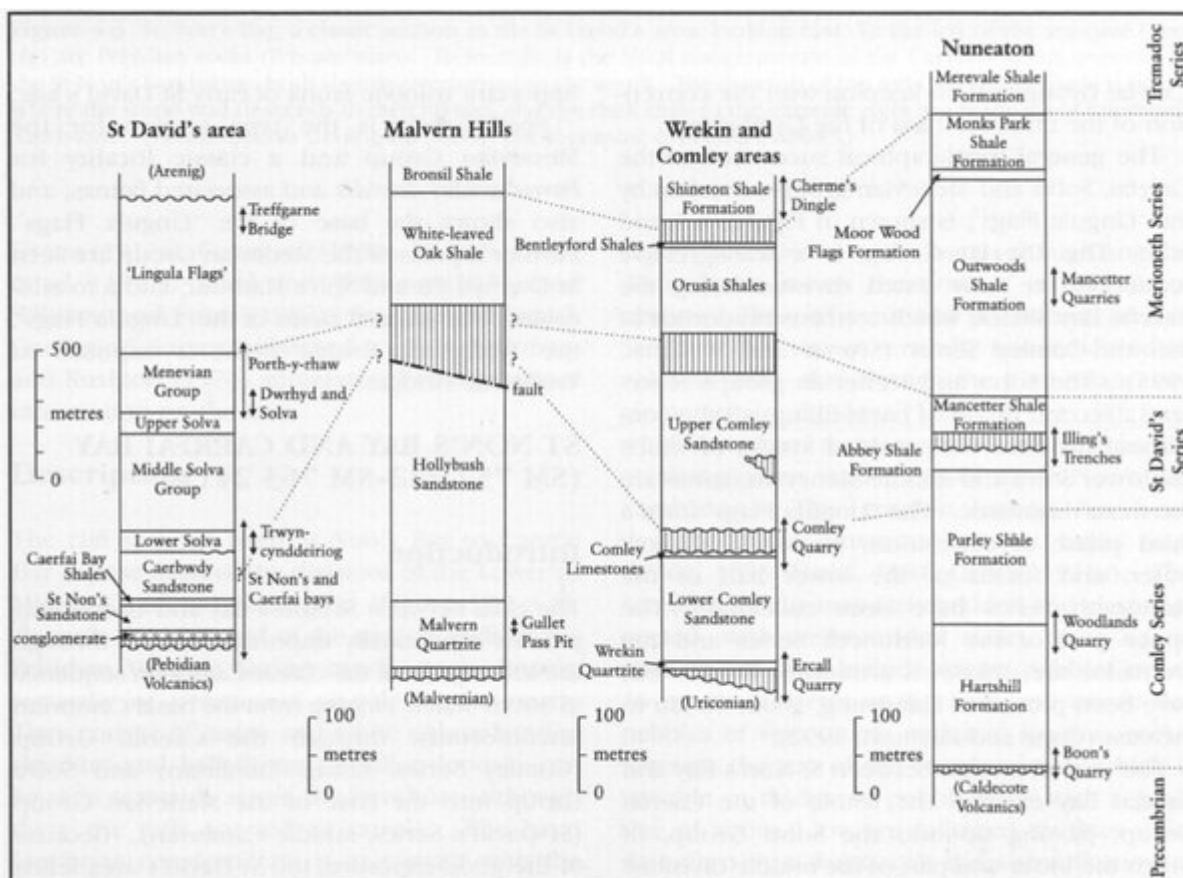
(Figure 3.1) Correlation of the principal Cambrian sequences in North Wales, modified from Rushton (1974, fig. 2). The arrows in this and succeeding figures indicate the stratigraphical ranges of individual GCR sites.



(Figure 4.2) Sketch of the Cambrian geology between St David's and Solva, south-west Wales, after the British Geological Survey (1973), with locations of the GCR sites.



(Figure 2.1) Distribution of Cambrian outcrops in England and Wales.



(Figure 4.1) Correlation of the principal Cambrian sequences in South Wales and England, modified from Rushton (1974, figs 2, 3). The stratigraphical ranges of the GCR sites are indicated. For the location of Treffgarne Bridge, see (Figure 8.1).

