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## Chapter 6 Wales, south and east of the Menai Strait

### Introduction

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The two sites covered by this chapter lie to the south-east of the Menai Strait Fault System (Figure 6.1), which is a major Precambrian crustal boundary (Figure 1.1). In contrast to sites dealt with in Chapter 7, which include outboard components of the Avalonian subduction system, such as blueschists, this chapter deals with rocks formed within a magmatic arc located inboard of the former subduction zone (Figure 1.4). The sites cover volcanic and volcanoclastic sequences belonging to the Pebidian Supergroup (St David's Peninsula GCR sites) and the Arfon Group (the Llyn Padarn GCR site), which are the principal outcropping representatives of the Cymru Terrane (see Chapter 1).

Geochemical studies reveal that the Arfon Group and Pebidian Supergroup rocks both possess similar calc-alkaline signatures (Bevins *et al.*, 1995), supporting their joint placement within a single terrane. That the magmatism of the two sequences was broadly contemporaneous is further suggested by U-Pb zircon ages, of  $614 \pm 2$  Ma for the Arfon Group (Tucker and Pharaoh, 1991) and  $587 \pm 2$  Ma for the St David's Granophyre, which is the youngest Pebidian component (Patchett and Jocelyn, 1979). Such ages place these igneous rocks within the main phase of Avalonian arc magmatism, as described by Gibbons and Horák (1996), identifiable in southern Britain and more extensively in the Avalonian of Maritime Canada. The two sites, however, show several contrasting features, the most notable of which is the fact that Arfon Group magmatism is dominated by acidic ash-flow tuffs, whereas the Pebidian Supergroup is predominantly composed of basic volcanic rocks.

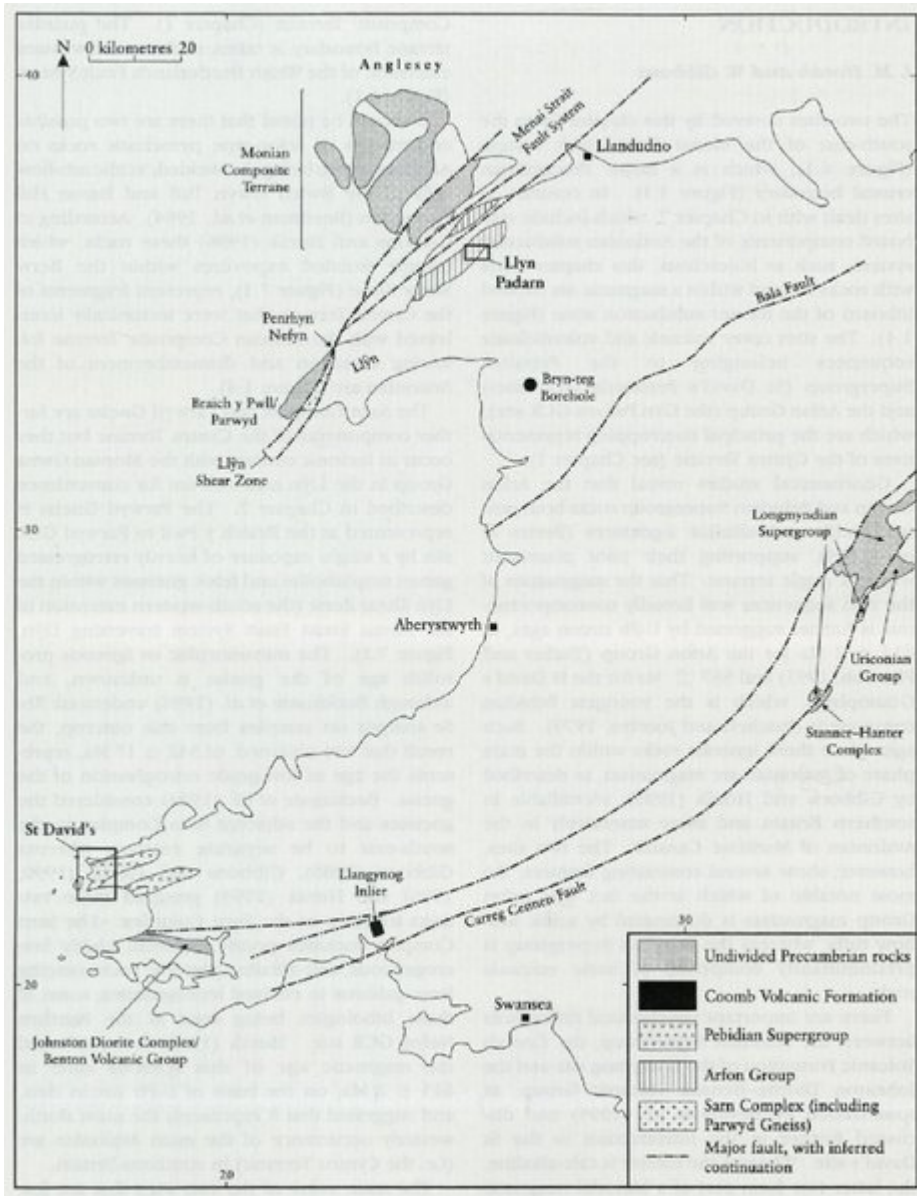
There are important geochemical differences between the Pebidian Supergroup, the Coomb Volcanic Formation of the Llangynog site and the Johnston Diorite–Benton Volcanic Group, as summarized by Bevins *et al.* (1995) and discussed further in the introduction to the St David's site. Whereas the former is calc-alkaline, the latter two form part of a bimodal magmatic suite with a more pronounced within-plate component. Such geochemical differences are the basis for suggesting that the Coomb Volcanic Formation and the Pebidian Supergroup may belong to different terranes within the Avalon Composite Terrane (Chapter 1). The putative terrane boundary is taken as the south-western extension of the Welsh Borderlands Fault System (Figure 6.1).

It should be noted that there are two possible occurrences of Arfon-type pyroclastic rocks on Anglesey, these being the welded, acidic ash-flow tuffs of the Bwlch Gwyn Tuff and Baron Hill Formation (Reedman *et al.*, 1984). According to Gibbons and Horák (1996) these rocks, which occupy isolated exposures within the Berw Shear Zone (Figure 7.1), represent fragments of the Cymru Terrane that were tectonically interleaved with the Monian Composite Terrane following cessation and dismemberment of the Avalonian arc (Figure 1.4).

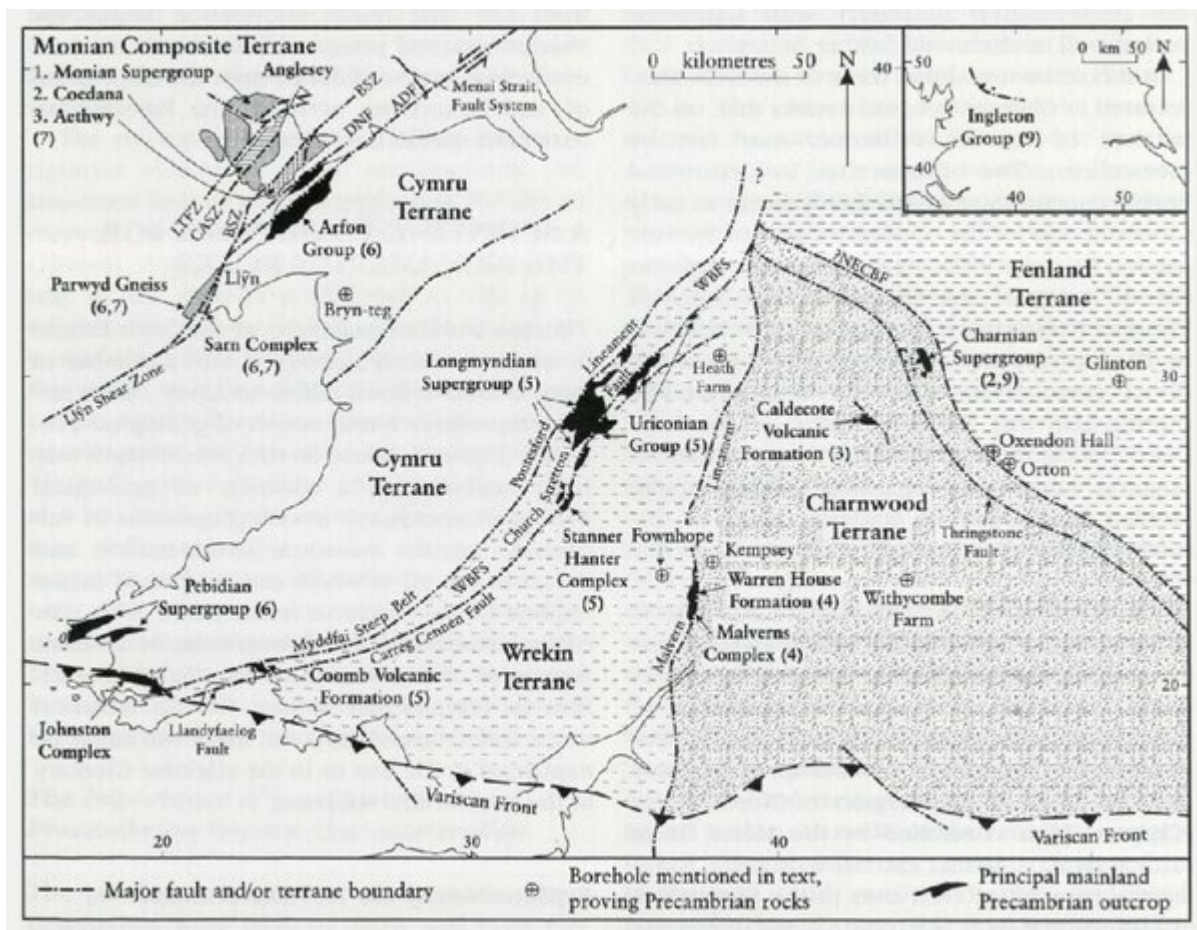
The Sarn Complex and Parwyd Gneiss are further components of the Cymru Terrane but they occur in tectonic contact with the Monian Gwna Group in the Llyn area and are for convenience described in Chapter 7. The Parwyd Gneiss is represented at the Braich y Pwll to Parwyd GCR site by a single exposure of heavily retrogressed garnet amphibolite and felsic gneisses within the Llyn Shear Zone (the south-western extension of the Menai Strait Fault System traversing Llyn, (Figure 7.1)). The metamorphic or igneous protolith age of the gneiss is unknown, and although Beckinsale *et al.* (1984) undertook Rb-Sr analysis on samples from this outcrop, the result that was obtained, of  $542 \pm 17$  Ma, represents the age of low-grade retrogression of the gneiss. Beckinsale *et al.* (1984) considered the gneisses and the adjacent Sarn Complex to the south-east to be separate entities, whereas Gibbons (1980), Gibbons and Horák (1990, 1996) and Horik (1993) grouped these two units together as the Sarn Complex. The Sarn Complex includes poorly exposed, highly heterogeneous, calc-alkaline plutonic rocks ranging from gabbros to evolved leucogranites, some of these lithologies being seen at the Penrhyn Nefyn GCR site. Horák (1993) has confirmed the magmatic age of this igneous suite as  $615 \pm 2$  Ma, on the basis of U-Pb zircon data, and suggested that it represents the most northwesterly occurrence of the main Avalonian arc (i.e. the Cymru Terrane) in southern Britain.

The main value of the two sites that are featured in this chapter rests upon the record they provide of some of the oldest geological events in southern Britain. Together with the evidence from the Coomb Volcanic Formation of the Llangynog site, they show how the Avalonian Precambrian arc changed with time, from one with a typical calc-alkaline signature to one involving a more complex, intraplate-type chemistry during later rifting of the arc. Such characteristics record the transition from steady-state subduction to extreme oblique subduction leading eventually to arc dissections (Figure 1.4), processes that are observed in modern and recent arc systems.

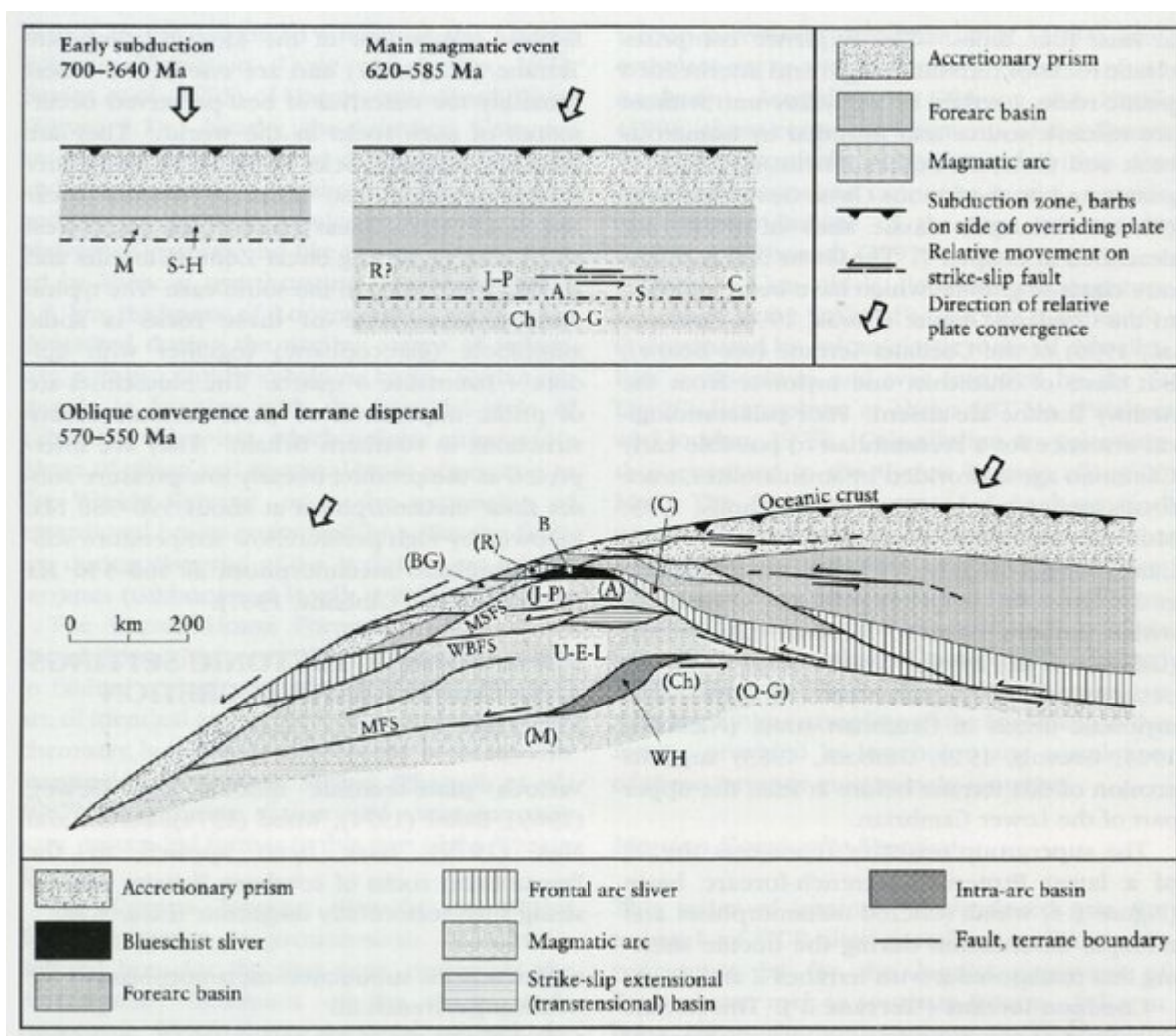
## References



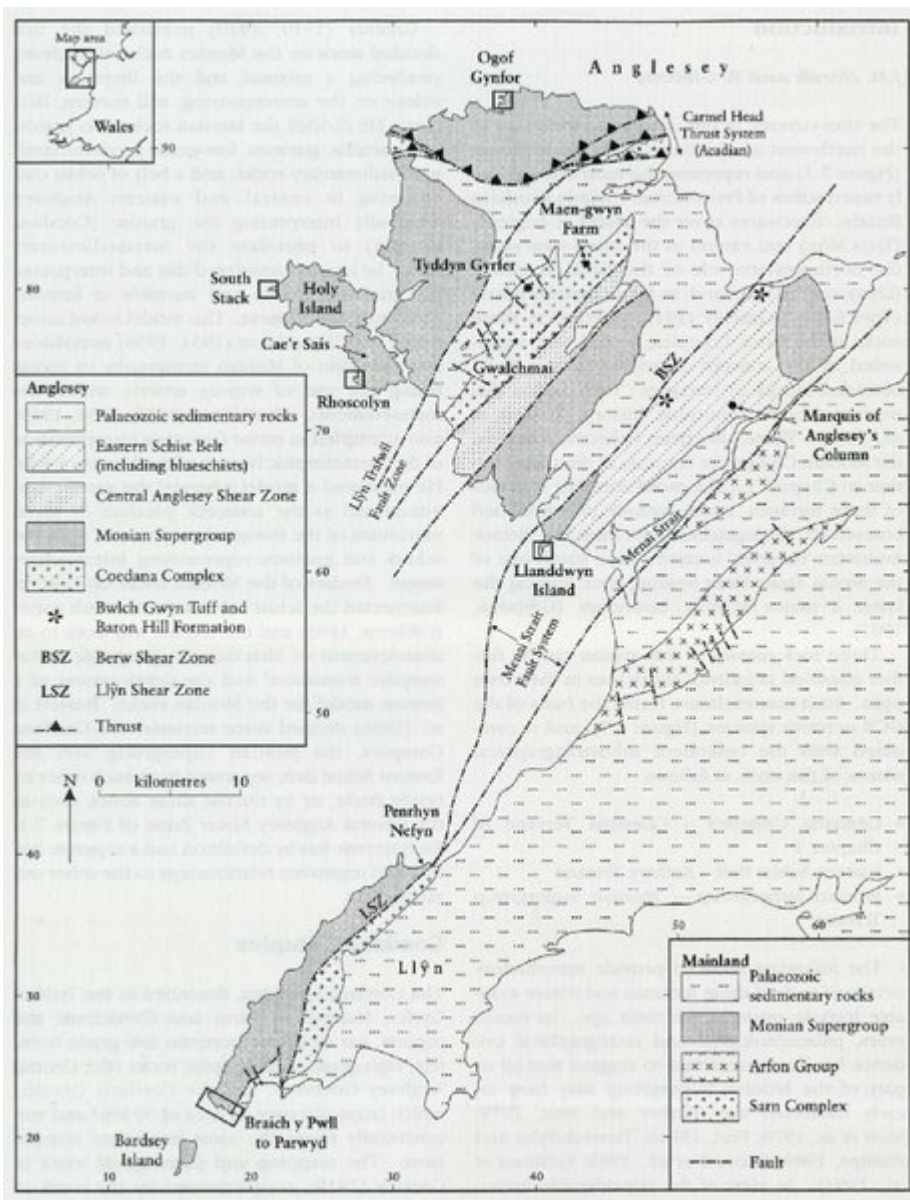
(Figure 6.1) Geological map showing the relationship of the St David's and Llyn Padarn sites to other Precambrian outcrops.



(Figure 1.1) Sketch map showing the distribution of Precambrian outcrop, and boreholes proving Precambrian rocks, in southern Britain. Note that the outcrops are labelled with the names of the principal geological units, followed by numbers (in brackets) of the chapters for the relevant GCR sites. Terrane boundaries are slightly modified after British Geological Survey (1996); Myddfai Steep Belt after Woodcock (1984a); Monian Composite Terrane after Gibbons and Horák (1990). Key: ADF, Aber-Dinlle Fault; BSZ, Berw Shear Zone; CASZ, Central Anglesey Shear Zone; DNF, Dinorwic Fault; LTFZ, Llyn Traffwll Fault Zone; ?NECBF, postulated NE Charnwood Boundary Fault. The boundary of the Midlands Microcraton basement domain is outlined by the NECBF and Pontesford-Myddfai lineament systems; WBFS, Welsh Borderland Fault System.



(Figure 1.4) Model for the late Precambrian evolution of the Avalonian subduction system: episodic Precambrian magmatism (top two cartoons) followed by the dispersal of terranes by transcurrent faulting along the plate margin as convergence became increasingly oblique during the latest Precambrian (modified from Gibbons and Horik, 1996). Note that the presence of the Monian Composite Terrane within this system cannot be proved until Arenig time. A = Arfon Group; B = Anglesey blueschists; BG = Bwlch Gwyn Tuff and related strata (Anglesey); C = Coedana Complex; Ch = Charnian Supergroup; J-P = Johnston Plutonic Complex and Pebidian Supergroup; M = Malverns Complex; MFS = Malverns lineament or fault system; MSFS = Menai Strait fault system; O-G = volcanics in Orton and Grinton boreholes; R = Rosslare Complex; S = Sam Complex; S-H = Stanner-Hanter Complex; U-E-L = Uriconian Group, Erccall Granophyre, Longmyndian Supergroup; WBFS = Welsh Borderland fault system; WH = Warren House Formation. The same letters in brackets (lower cartoon) refer to the relative positions of those volcanic belts that were by then extinct.



(Figure 7.1) Geological map showing simplified geology and location of GCR sites (bold lettering) in the Anglesey–Llyn region.