Hanter Hill

[SO 252 572]

Potential GCR site

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Introduction

The choice of Hanter Hill as a GCR site is justified by its excellent exposures of the Stanner–Hanter Intrusive Complex. The importance of these rocks lies in the fact that they represent what is possibly the oldest and, compared to the Malverns Complex, the least deformed, intrusive igneous association to be found in the English and Welsh Precambrian terranes. The earliest accounts of the Stanner–Hanter Complex are those of Murchison (1839, 1867), who described it as a 'hypersthene trap' intrusive into Ludlow (late Silurian) sedimentary strata. Callaway (1879) envisaged the complex to form a continuation of a ridge of Precambrian rocks stretching southwards from Lilleshall Hill and the Wrekin. Cole (1886) who classified the igneous rocks of Stanner but did not discuss their age provided the first petrological descriptions of the complex.

In past years there has been much debate over the age and affinities of these rocks. Callaway (1900) expounded upon his earlier ideas when he compared them with certain lithologies of the Church Stretton area, and suggested that the Stanner–Hanter Complex was of Uriconian type and probably Archaean' in age. On the other hand, Raw (1904) believed the exposed mass of Hanter Hill to be a Carboniferous laccolithic body intrusive into the Ludlow strata. Watts (1906) suggested that the complex was Tertiary in age on the basis of supposed petrographical similarities with the igneous complexes of Skye. Pocock and Whitehead (1935) followed Raw's ideas in suggesting that the complex was intrusive into Silurian shales and represented the continuation of an ESE–WSW trending belt of Carboniferous basalts and dolerites, which included the Clee Hills and Wyre Forest. Detailed petrographical and petrological studies carried out by Holgate and Hallowes (1941) resulted in a re-classification of the main rock types and elucidation of the order of intrusion. They further concluded that the complex had the form of a fault-bounded inlier located along the southerly extension of the Church Stretton Fault System. This is now known to be a Precambrian terrane boundary (Figure 1.1), and is in reality a plethora of structures with complicated movement histories, as discussed by Woodcock (1988). Holgate and Hallowes favoured a probable Precambrian age for the Stanner–Hanter rocks, partly because of their petrographical similarities to intrusions associated with the Uriconian Group of the Wrekin. They also found, however, that closely similar igneous rock types occur as pebbles in 'Longmyndian' conglomerates, described earlier in this chapter at the adjacent Dolyhir and Strinds GCR site. The latter observation, if verified, would indicate not only that the complex is Precambrian in age, but also that it was rather older than the Uriconian Group, having been exhumed and exposed to erosion prior to accumulation of the Longmyndian Supergroup.

The controversy over the age of the Stanner–Hanter rocks has been partly resolved by an Rb-Sr isochron date of 702 ± 8 Ma, obtained by Patchett *et al.* (1980), on a granophyre (an 'Acid Type' according to Holgate and Hallowes) from the summit of the Stanner ridge, north-east of Hanter Hill. Given the evidence discussed below, of substantial magma mixing within these rocks, this value may represent an emplacement age for the entire complex.

Description

The three en-echelon ridges that make up the Stanner–Hanter Inlier comprise, from NNE to SSW: Stanner, Worsell Wood and Hanter Hill. The outcrops of Stanner and Worsell Wood are poorly exposed owing to forestation and consequently only the better exposures, limited to Hanter Hill (Figure 5.20), are described here. No formal redefinition of these rocks has been made, and the terminology adopted follows the rather dated scheme of Holgate and Hallowes (1941).

According to Holgate and Hallowes the oldest component of the complex is the 'Fine Dolerites', which occupy the majority of north facing slopes on Hanter Hill. The best exposures are on crags [SO 2525 5754] above Lower Hanter Farm ((Figure 5.21), Locality 1) and along the footpath [SO 2553 5740] leading to Red Vallet Wood. At outcrop the dolerites (which include microgabbros) are fine-grained, variable in colour, and show textures ranging from ophitic to porphyritic. Primary structures are not visible owing to subsequent deformation and weathering. In thin section the main varieties comprise olivine-free, pyroxene (augite) dolerites with interstitial quartz, and quartz dolerites. Fresh samples are rare, however, owing to the pervasive alteration of primary minerals to green hornblende, actinolite, epidote, chlorite and albite.

At Red Vallet Wood (Locality 2) a tongue of very coarse-grained gabbro crosses the footpath [SO 2565 5734] and forms a prominent NE–SW trending ridge that leads to the summit plateau. This ridge and its crags are composed of the quartz-free gabbros of Holgate and Hallowes (1941). In thin section fresh samples of this variety are composed entirely of augite and plagioclase (labradorite); however, the present writer collected one sample containing the assemblage: orthopyroxene, clinopyroxene, plagioclase and quartz. In these gabbros the primary assemblage is commonly altered to green-hornblende, actinolite, epidote and chlorite.

On the lower crags of the ridge [SO 2554 5724], the gabbro sheet becomes finer grained and develops a porphyritic texture towards its margins. Emplaced along this contact with the Fine Dolerites are several sheets of fine-textured granophyric granite, and biotite-microcline granites, representative of the 'Acid Types and hybrids' of Holgate and Hallowes (1941); these minor granitic sheets are thinner where they are exposed on the summit. On the lower, south-facing slopes leading to the summit (Locality 3) a chilled margin between individual gabbro sheets is exposed [SO 2537 5710]. This contact contains relict screens of the Fine Dolerites, and thin 1 m-wide sheets of biotite granite have subsequently invaded it. The granite sheets enclose abundant dolerite xenoliths, many of the latter displaying 'corrugated' rims, the significance of which is discussed below.

On the summit plateau (Locality 4) the contact between the coarse, quartz-free gabbro and a plagioclase phenocryst-bearing, coarser-grained facies of the Fine Dolerites is well exposed south-westwards towards the cairn. The gabbro sheets and the dolerites are there truncated by the major NW–SE trending fault, which dissects the complex. To the south of this fault [SO 2517 5710] is exposed the largest granitic body of the complex, the granophyric quartz porphyry of Holgate and Hallowes (1941), although it is poorly exposed and intensely fractured by the fault.

Most of the south- and south-west-facing slopes leading from the summit are in quartz-free gabbros. Near the summit these gabbros are strongly leucocratic but farther south, towards Upper Hanter Farm, they become melanocratic. On the western slopes [SO 2517 5705], overlooking Knowle Barn (Locality 5), there are scattered exposures of spectacular gabbro pegmatite featuring plagioclase laths and green-hornblende crystals, the latter up to 5 cm in length and replacing primary augite. These exposures show that the primary mineral assemblage of the gabbros displays various degrees of alteration, to green hornblende, actinolite, epi-dote and chlorite. The lower contact of the gabbro against the Fine Dolerites is seen on the craggy slopes [SO 2500 5687] above Upper Hanter Farm (Locality 6). It contours around the hill slopes, suggesting the body has the geometry of a shallow-dipping sheet, and is located in the vicinity of a line of small hawthorn trees. Inspection of these crags shows important primary structures that provide key evidence bearing on the nature and emplacement age of the gabbro. Internal variation within the gabbro is indicated, for example, by the abundant 'Fine Dolerites' xenoliths, up to 1 m in diameter, and relict primary layering in more mafic units near the basal contact, and by the more leucocratic and pegmatitic nature of its higher part. The gabbro itself is melanocratic and many of the crags exhibit primary compositional layering. Furthermore, the gabbro contains abundant tourmaline mineralization, the development of which is linked to the intrusion of fine-grained granite sheets (Holgate, 1977). In a small quarry to the west, located above the footpath [SO 2495 5688], there are several sheets of fine-grained biotite granite interleaved along the lower contact of the gabbro and also intruded into the underlying Fine Dolerites.

A further small quarry [SO 2492 5690] above Roxiana (Locality 7) shows in its backwall excellent exposures of the youngest components of the complex. These consist of several fine-grained dolerite dykes, the 'Later Dolerites' of Holgate and Hallowes (1941), cutting the gabbro. In thin section the dolerites are unaltered, with ophitic to sub-ophitic textures and olivine phenocrysts.

Interpretation

The Hanter Hill inlier is an excellent example of a relatively undeformed late Precambrian bimodal (gabbro-granophyre) magmatic complex. Four intrusive stages are recognized, which from oldest to youngest are: 'Fine Dolerites', Gabbro, 'Acid Types and hybrids' and 'Later Dolerites' in the terminology of Holgate and Hallowes (1941). The earliest stage, represented by the Fine Dolerites, probably resulted from the multiple injection of basic magmas as a series of sheets; however, their limited outcrop, fine-grain size and absence of observable primary structures renders them difficult to interpret. The Fine Dolerites were in turn intruded by coarse-grained, quartz-free gabbros, which in the north of the complex form thick near-vertical sheets with internal chills delineating the margins of individual components. On the southern slopes a larger and more homogeneous gabbro, with a shallow-dipping lower contact, is interpreted as a fragment of a small magma chamber.

The subsequent emplacement of the 'Acid Types and hybrids' (granites, granophyres and porphyries), was favoured by zones of structural weakness that had developed within the gabbro. The production of the hybrids is a result of high-temperature physical and chemical interactions between the hot doleritic and gabbroic country rocks and invading granitic sheets, according to Holgate and Hallowes (1941). Furthermore, in the abundant dolerite xenoliths the presence of cuspate or 'corrugated' rims is an unusual feature, which in other parts of the world (Vernon, 1983) is most commonly reported where acid and basic magmas are suspected to have 'mingled' together when still in a molten or semi-solidified state. The Later Dolerite dykes mark the final phase of the intrusive sequence.

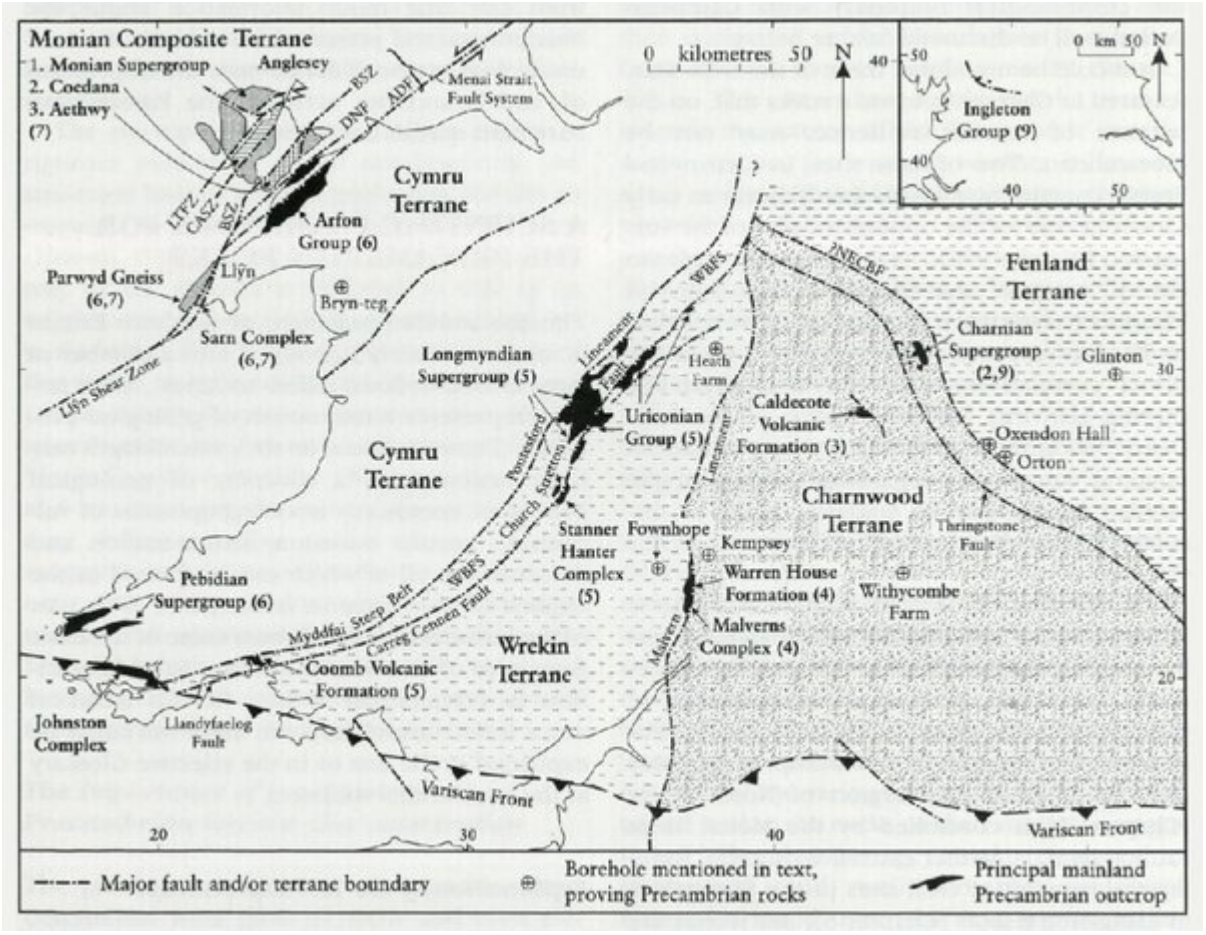
The dolerites and gabbros were subsequently altered to mineral assemblages akin to those of the low-amphibolite and greenschist facies of regional metamorphism. Holgate and Hallowes (1941) speculated, however, that this alteration, and the tourmalinization of the gabbros, are phenomena associated with hydrothermal activity linked to the intrusion of the 'Acid Types'.

The plate tectonic affinities of the Stanner–Hanter Complex must await the results of further geochemical study. It probably represents a remnant of a magmatic 'feeder' zone located within the roots of a volcanic arc, although the radiometric evidence suggests that this was somewhat older than the volcanism that gave rise to the Uriconian Group of Shropshire and Llangynog (Figure 1.4).

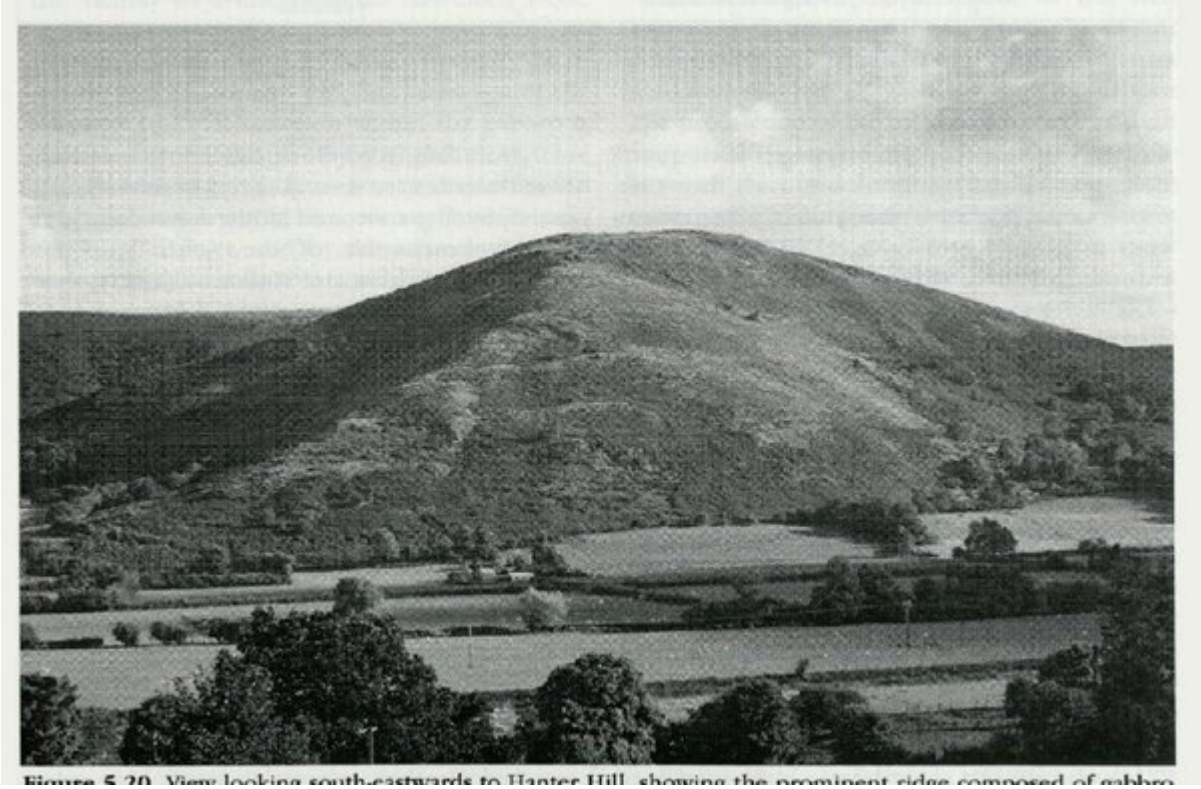
Conclusions

The exposures of Hanter Hill give a unique insight into processes accompanying the emplacement of the Stanner–Hanter Complex, which is an example of a bimodal (gabbro-granophyre) intrusive association forming part of the igneous basement to the western Wrekin Terrane (Figure 1.1). The majority of the lithologies are basic in composition, but a significant acidic component is also seen as sheet-like granitic intrusions. These were evidently emplaced close to the time of the basic magmatism, resulting in excellent examples of some very rarely reported features that are attributed to the 'mingling' together of magmas with contrasting compositions. The *c.* 702 Ma Rb-Sr radiometric age obtained on the granitic rocks suggests that the Stanner–Hanter Complex may be one of the oldest igneous assemblages within the basement of southern mainland Britain (Figure 1.2).

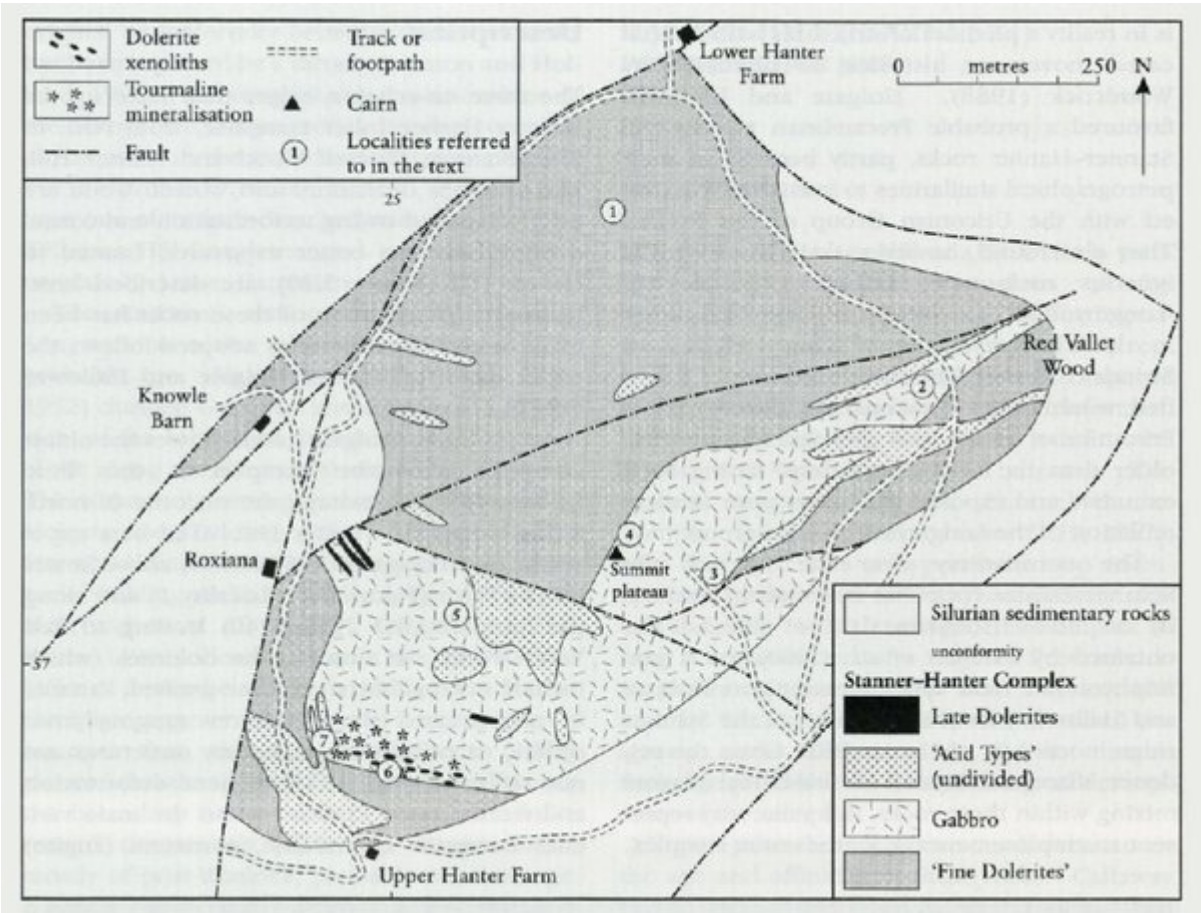
References



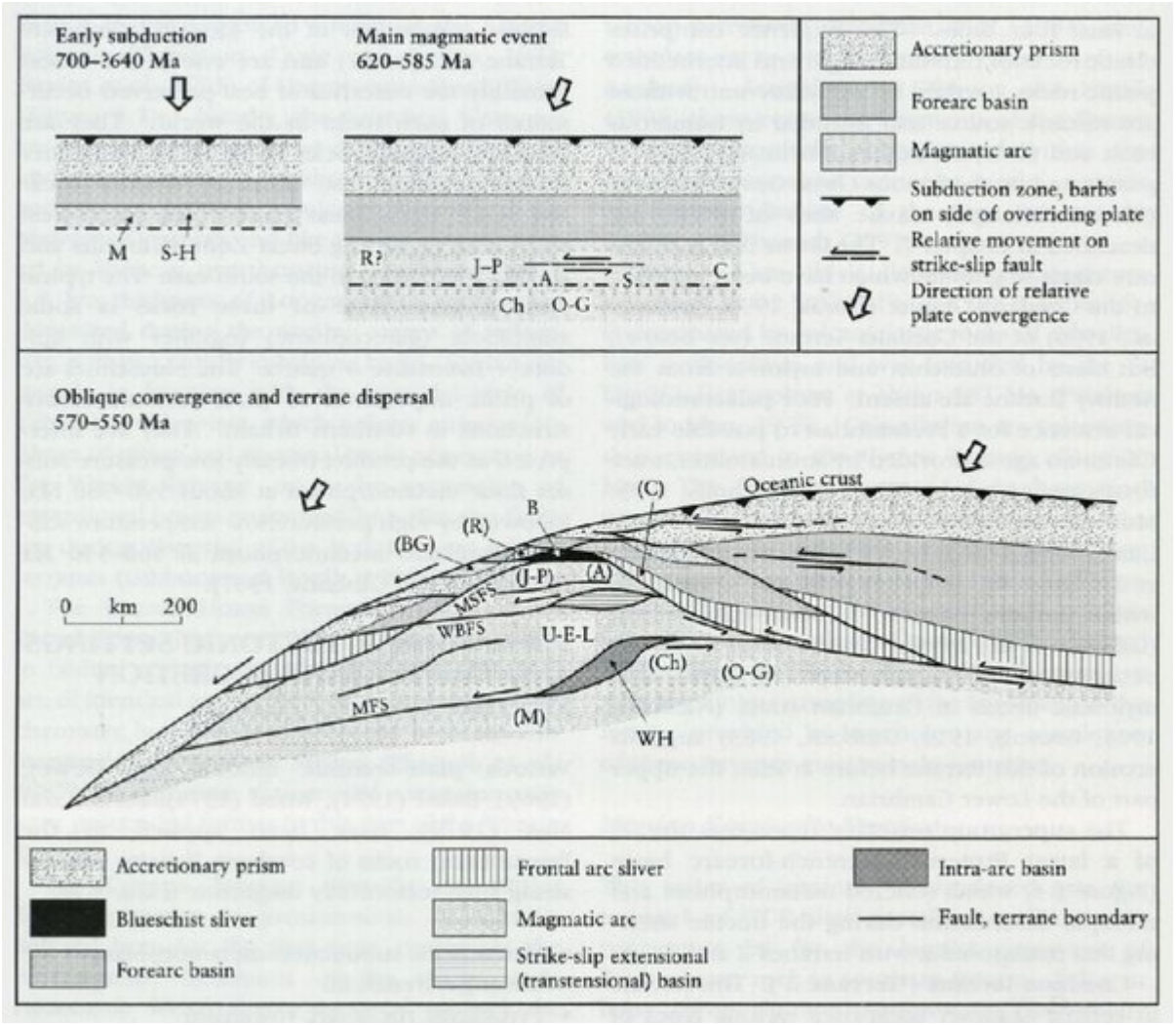
(Figure 1.1) Sketch map showing the distribution of Precambrian outcrop, and boreholes proving Precambrian rocks, in southern Britain. Note that the outcrops are labelled with the names of the principal geological units, followed by numbers (in brackets) of the chapters for the relevant GCR sites. Terrane 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.



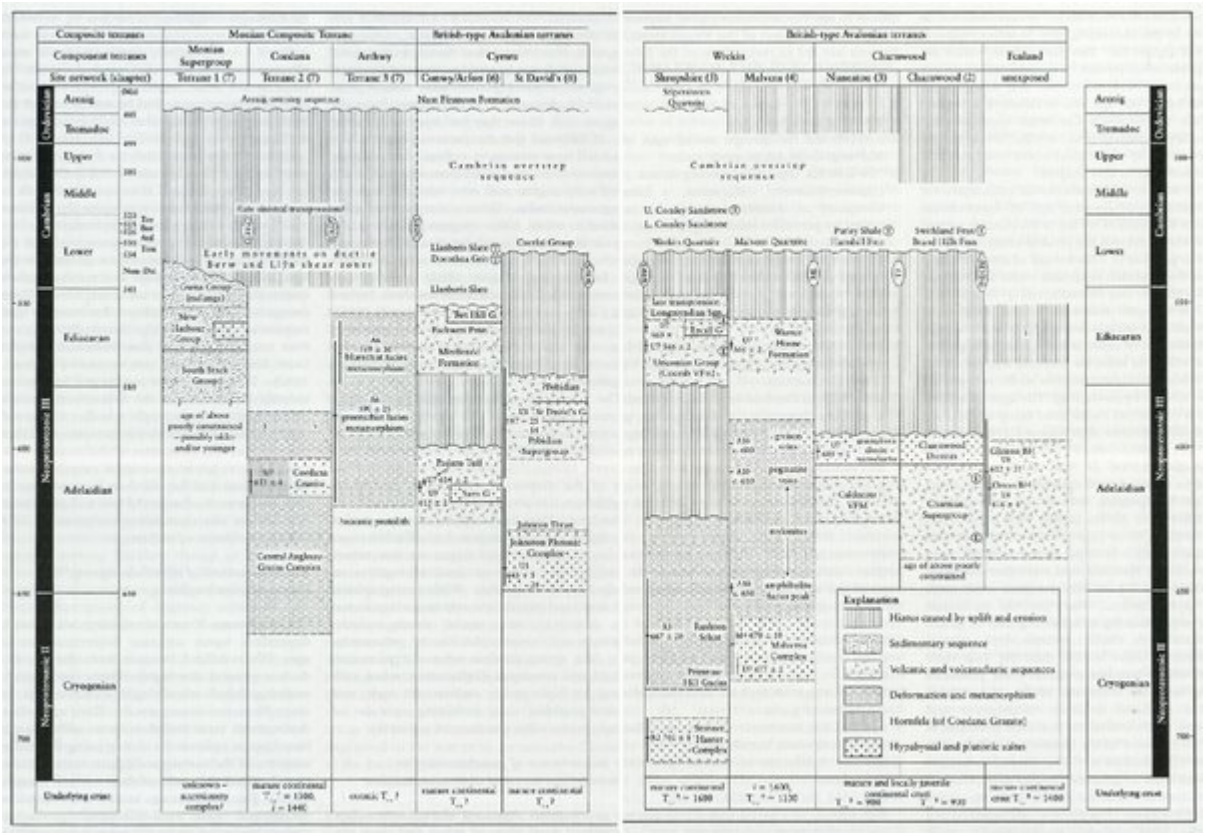
(Figure 5.20) View looking south-eastwards to Hanter Hill, showing the prominent ridge composed of gabbro and lower north facing crags of 'Fine Dolerites'. (Photo: K.A. Jones.)



(Figure 5.21) Geological sketch map of Hanter Hill (modified after Holgate and Hallowes, 1941).



(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 Glinton boreholes; R = Rosslare Complex; S = Sam Complex; S-H = Stanner-Hanter Complex; U-E-L = Uriconian Group, Ercall 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 1.2) Correlation chart for the late Neoproterozoic history of southern Britain. Key: A, ^{40}Ar–^{39}Ar age; M, U-Pb monazite age; R, Rb-Sr whole-rock isochron age; U, U-Pb zircon age; T_{DM}, Depleted mantle Sm-Nd age; i, inherited zircons. Key to faunas; (E) Ediacaran fossils; (T) Teichichnus trace fossils. Key to horizontal boundaries; continuous line, conformable stratigraphy; wavy line, unconformity; dashed T line, tectonic contact; dashed line, nature of contact uncertain. Terrane boundaries: BSZ, Berw Shear Zone; CASZ, Central Anglesey Shear Zone; LTFZ, Llŷn Traffwll Fault Zone; ML, Malvern Lineament; MSFS, Menai Strait Fault System; ?NECBF, postulated NE Charnwood Boundary Fault; TF, Thringstone Fault;WBFS, Pontesford Lineament of Welsh Borderland Fault System. Literature sources: 1, Patchett and Jocelyn (1979); 2, Patchett et al., (1980); 3, Beckinsale et al., (1984); 4, Thorpe et al., (1984); 5, Davies et al., (1985); 6, Dallmeyer and Gibbons (1987); 7, Tucker and Pharaoh (1991); 8, Noble et al., (1993); 9, Horák et al., (1996); 10, Strachan et al., (1996). Stratigraphical data for Lower Cambrian sequence, and fossil occurrences after McIlroy et al., (1998): nem-Dal, Nemakit-Daldynian; Tom, Tommotian; Atd, Atdabanian; Bot, Botomian; Toy, Toyonian.