Tyddyn Gyrfer

[SH 383 808]

Potential GCR site

J.M. Horák

Introduction

The Tyddyn Gyrfer site (Figure 7.2) provides a small but informative exposure of interleaved paragneisses and amphibolites, representative of the upper amphibolite facies gneisses of the Coedana Complex. This site is important because exposures of high-grade metamorphic rocks are uncommon within the Neoproterozoic of southern Britain, and those with a metasedimentary protolith are even rarer. In addition to this, it was from here that Horák (1993) sampled the gneisses for Sm-Nd whole-rock analyses. These data, along with petrological information, support a correlation between the Coedana Complex and the Rosslare Complex of southeast Ireland.

The main occurrence of Coedana Complex gneisses lies to the north-west of the main Coedana Granite outcrop and consists of both metasedimentary rocks and metabasites. Two further highly cataclased exposures of gneisses, the Nebo and Gader inliers, crop out in the north-eastern and north-western corners of the island respectively and form slices within the Carmel Head Thrust System (Figure 7.1). Migmatized pelites and semi-pelites dominate the metasediments, but minor occurrences of calc-silicate gneisses are present in the Nebo Inlier.

The relationship between the gneisses, hornfels and granite has elicited much debate. Blake (1888) first differentiated the paragneissic and

orthogneissic components. Subsequently, Greenly (1919) interpreted the gneisses as the old gneissic basement to the Monian Supergroup. One of the most significant findings of his detailed mineralogical and textural study was the identification of sillimanite as part of a garnet-biotite gneiss assemblage. A controversial re-interpretation of the gneisses was made by Shackleton (1954, 1956), who proposed that rather than being an old basement, they could be interpreted as part of a metamorphic transition from the low-grade Monian Supergroup metasediments, via Penmynydd schists, with the Coedana Granite as the final product of ultra (high-grade) metamorphism. Subsequent works refuted Shackleton's model and re-established that of Greenly. Gibbons (in Bassett *et al.* , 1986) grouped the gneisses, hornfels and granite together as the Coedana Complex.

All attempts at establishing the age of high-grade metamorphism of the gneisses have so far failed. Published data giving a range of ages from 389 11 to 447 ± 22 Ma (from Rb-Sr and K-Ar methods) are considered, at best, to record the timing of retrogression (Fitch *et al.,* 1964, 1969; Moorbath and Shackleton, 1966). The relationship between the gneisses and the granite and hornfels remains unproven, in part because of this uncertainty of the timing of metamorphism, and also because contact relationships are either faulted or unexposed.

All exposures within the Coedana Complex gneisses reveal the effects of retrogression and weathering. This site has been selected as it shows a representative upper amphibolite facies assemblage of biotite, garnet and sillimanite, which can be viewed in hand specimen, in addition to providing exposures that show the juxtaposition of amphibolite and paragneisses.

Description

The site (Figure 7.3) lies in the central area of the gneiss outcrop and forms a low rocky exposure. The dominant lithology is pale-weathering biotite-garnet-sillimanite gneiss showing banding on a 2–3 mm scale. More mafic parts contain biotite, with visible retrogression to chlorite, and subhedral almandine-rich garnets, typically up to 3 mm in diameter. The leucocratic portions have a simple assemblage of quartz and feldspar. Locally, biotite and garnet are associated with silky aggregates of sillimanite fibres a few millimetres in length. In thin section good prismatic sillimanite is observed, commonly showing biotite replacement textures similar to those described from Scotland by Chinner (1961). The gneiss is cut by leucogranite veins ranging from thin, impersistent veins less than 10 mm in width, lying sub-parallel to the metamorphic banding, to larger pods of granite typically 0.1–0.15 m in width. The foliation strikes approximately east–west and varies from moderately inclined to sub-vertical due to the presence of open folds.

The west side of the exposure reveals the presence of pale green-weathering amphibolite layers interleaved with the paragneiss. The amphibolite is fine-grained with a well-developed foliation and leucocratic segregations a few millimetres thick, which persist over distances of 30–40 cm. Unfoliated pods of feldspar and hornblende are locally present. In thin section the amphibolite shows retrogression to an assemblage of albitized and sericitized plagioclase, and hornblendic amphibole replaced by actinolite and chlorite.

Interpretation

The petrological studies of Greenly (1919) and Horák (1993) indicate that the mineralogical assemblage within the paragneisses is diagnostic of upper amphibolite facies conditions within the sillimanite stability field. Unfortunately, the state of retrogression in the biotite and feldspar precludes more detailed thermobarometric calculations to determine the precise temperature and pressure conditions of metamorphism. On the basis of amphibolite mineralogy, however, an approximation to these conditions would be temperatures above the granite-wet solidus, within the sillimanite stability field, and pressures between 2.7 and 5 Kb. As the metamorphic layering does not contain distinct melanosomes and neosomes, the possibility exists that these may represent injection migmatites (Winkler, 1979); in this instance, however, the melt is considered to be derived from melting of Coedana Complex paragneisses as opposed to a Coedana Granite source. Exposures at Mynydd Mwyn-Mawr, 2.5 km to the north-east of this site, although lacking diagnostic metamorphic minerals, show clear migmatite textures in pelites and semi-pelites. The amphibolites are interpreted as thin sills or dykes intrusive into the paragneiss protolith. Where preserved, the original amphibolite mineral assemblage of amphibole (typically magnesio-hornblende) and plagioclase is consistent with upper amphibolite conditions of metamorphism although the state of retrogression precludes more specific determination of pressure and temperature conditions.

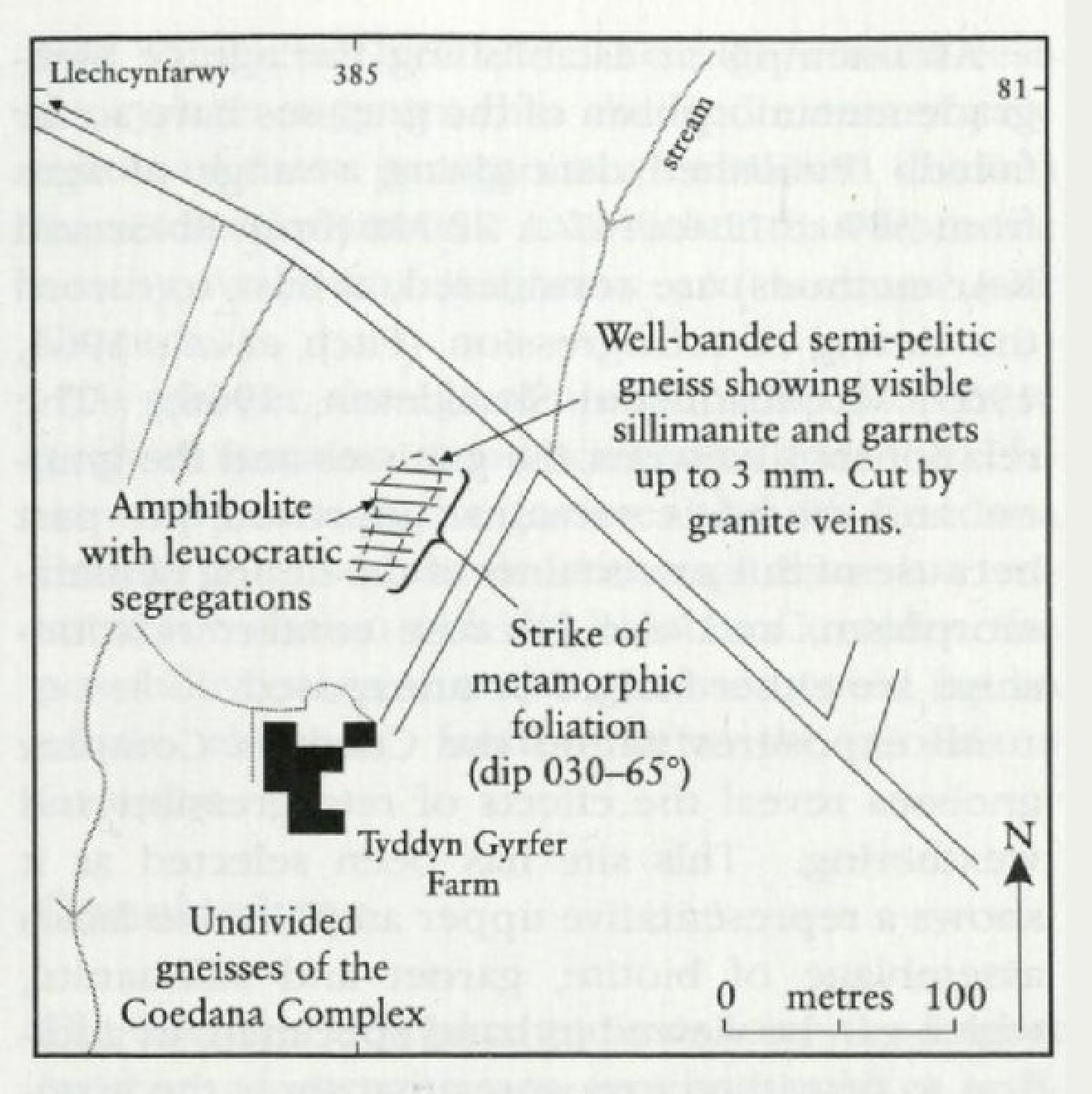
Paragneiss samples from this locality were analysed for Sm-Nd isotopes by Horák (1993). Attempts to determine a metamorphic age from whole-rock-garnet Sm-Nd pairs failed to produce reliable results due to insufficient rare earth element fractionation by the garnet. Whole-rock Sm-Nd data showed, however, that the paragneisses have crustal residency ages of 1800 Ma, considerably older than most other Neoproterozoic rocks in southern Britain, but consistent with the ages yielded by the Rosslare Complex in south-east Ireland. These crustal residency ages, combined with whole-rock geochemical and isotopic data from the amphibolites, support previous correlations made between these two crystalline complexes (Gibbons, 1990), and serve to show the southwestward extension of the Coedana Complex into south-east Ireland. The high crustal residency age suggests that the sedimentary pro-toliths of these paragneisses contained detritus from an older cratonic area rather than from the nearby Avalonian magmatic arc terranes (see Chapter 1).

At present, the age of metamorphism of these gneisses remains unconstrained as does the relationship between the gneisses and the Coedana Granite and its hornfels. Although there is a tentative correlation with the Rosslare Complex, the possibility exists that the gneisses could be an exotic element, faulted into the Coedana Complex.

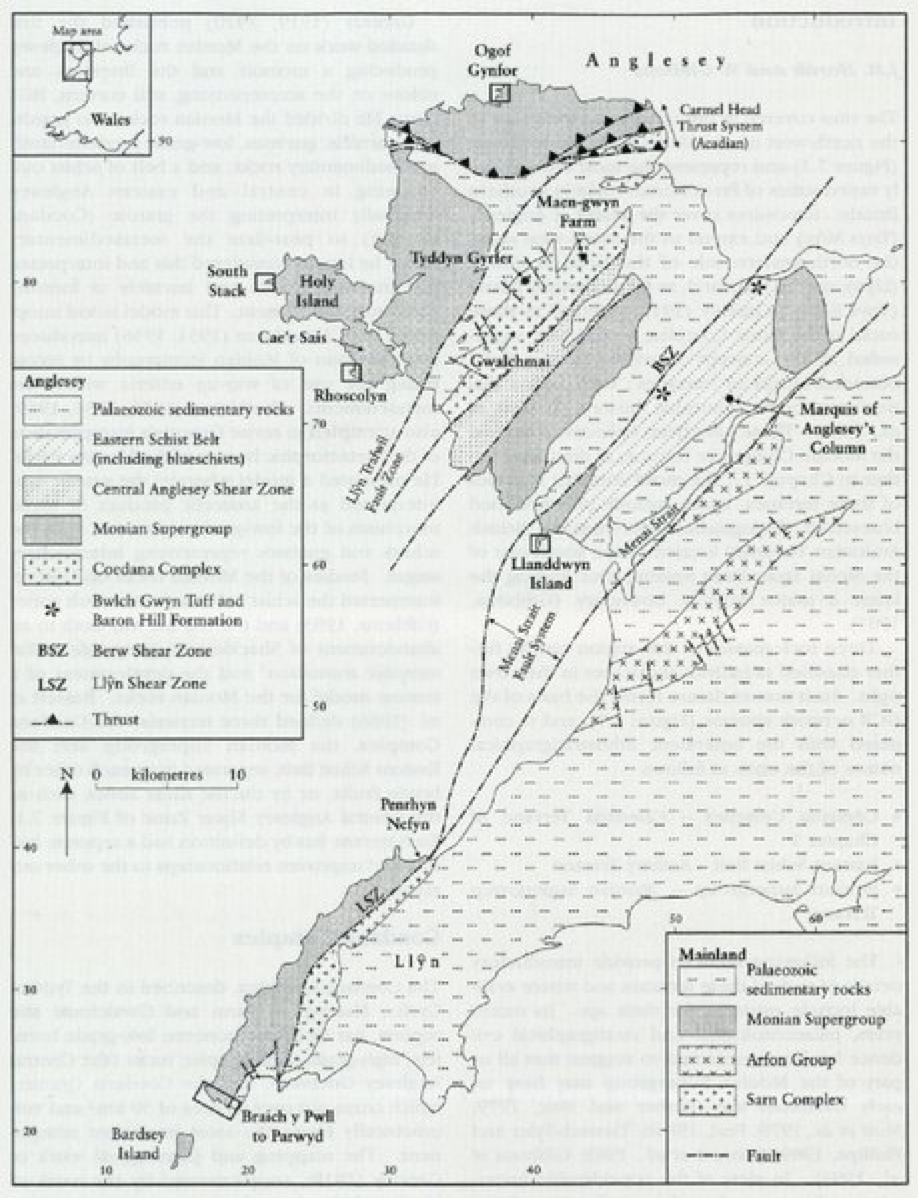
Conclusions

The Coedana Complex gneisses form the largest outcrop of paragneisses (gneisses with a sedimentary protolith) in southern Britain, and this site in particular provides representative exposures of rocks metamorphosed at upper amphibolite facies within the Complex. Isotopic data obtained from this site have supported the correlation with the Rosslare Complex of south-east Ireland, providing evidence for the extension of the Coedana Complex across the southern Irish Sea.

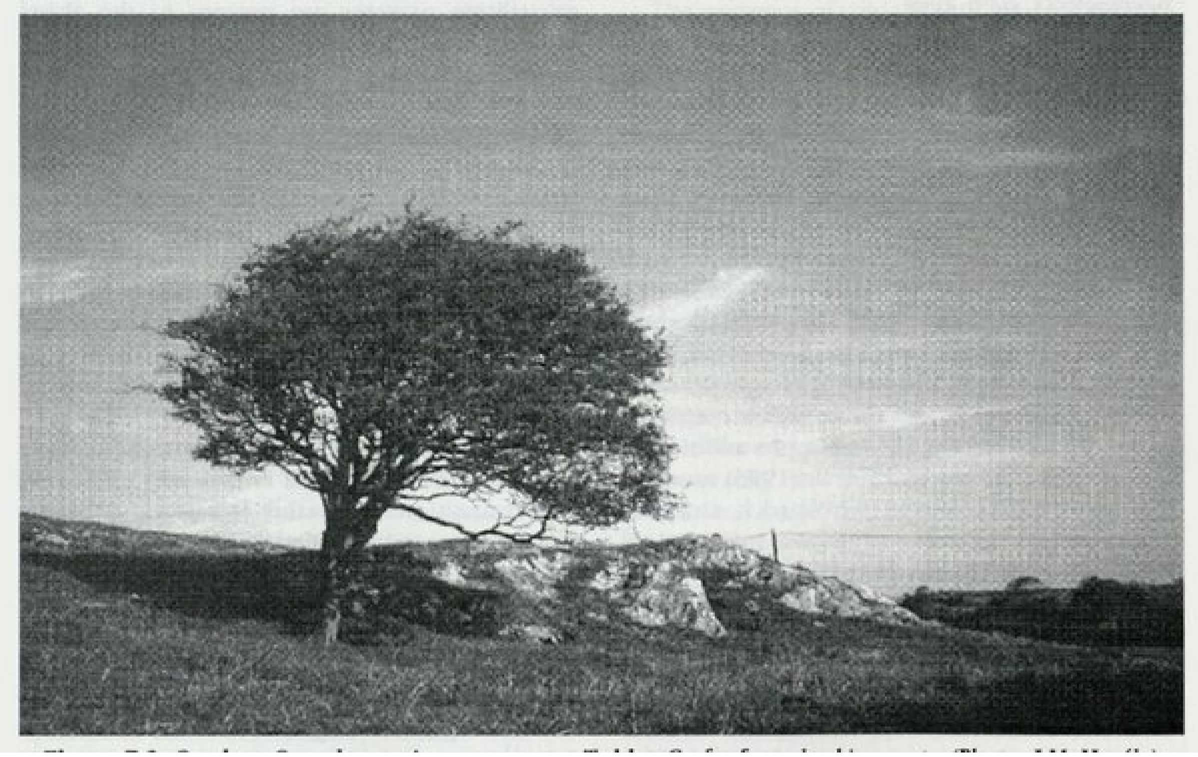
[References](#)



(Figure 7.2) Locality map of the Tyddyn Gyrfer site.



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



(Figure 7.3) Coedana Complex gneiss exposures at Tyddyn Gyrfer farm, looking east. (Photo: J.M. Horák.)