
Gwlachmai Quarry RIGS site

NRW RIGS no. 189 [SH 38232 77006]

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RIGS Statement of Interest:

Gwlachmai Quarry RIGS site provides excellent exposures of the Coedana Granite and is of national importance. It is one of five units constituting the Precambrian Coedana Complex and comprises the most extensive outcrop of plutonic igneous rock within the Monian Composite Terrane. This quarry contains three discrete facies, namely, 1. Porphyritic granite (large crystals within a matrix of smaller crystals) which were unexposed at the time of writing the GCR report but which are now visible at the north-eastern side of the quarry. This facies continues outside the quarried area, in the ridge to the east of Cerrig Moelion. 2. Non-porphyritic granite can be seen in various parts of the quarry but originally it formed the bulk of the original outcrop which has been largely extracted. 3. Aplite veins (fine-grained granite consisting of quartz and feldspar) which were intruded into the granite mass at a late stage of granite emplacement. Original textures have been largely overprinted by a later phase of ductile (plastic) deformation that caused extensive recrystallization and the development of an impersistent rodding fabric and foliation. Geochemical data indicate that the Coedana Granite can be classified as a monzogranite (granite containing the dark mineral augite), which formed within a volcanic arc setting. A U-Pb age of 614 ± 14 Ma confirms a late Precambrian age of crystallization. The types of minerals in the Central Anglesey Shear Zone along the south-eastern margin of the granite suggest that the Coedana Complex may represent a sliver of the main Avalonian arc. This sliver was transported an unknown distance south-westwards along the Avalonian subduction complex into its present position. The granites are thought to have been derived from the melting of much older crustal rocks (1,330 – 1,443 Ma) over 30 km beneath the Earth's surface over 600 Ma ago. This site is important for magmatic studies and has great research potential.

Geological setting/context: The Precambrian basement rocks of Anglesey and south-west Llyn can be divided into several discrete groups, all of which were juxtaposed along a series of steep, brittle and/or ductile faults and shear zones (e.g. Dinorwic and Aber-Dinlle faults; Berw, Central Anglesey and Llyn shear zones) collectively referred to as the Menai Strait Fault System (MSFS). First, the Monian Supergroup consists of a thick sequence of polydeformed metasediments and meta-igneous rocks, comprising the South Stack, New Harbour and Gwna groups, the latter representing the type example of a large-scale submarine debris flow or *mélange* said by some researchers to be of Lower Cambrian age. Ongoing research, however, may suggest a much older date for the Gwna Group with possible Cambrian ages being put forward for the South Stack metasediments. Second, the Coedana Complex of central Anglesey comprises high-grade metasediments, amphibolites and gneisses, and low-grade, thermally metamorphosed hornfelses adjacent to a granite (Coedana Granite), which has recently yielded a late Precambrian zircon age of 614 ± 4 Ma. Third, a belt of schists and metabasites displaying blueschist facies grade of metamorphism lies within the MSFS. The metabasites exhibit a strong mid-ocean ridge basalt signature and have yielded ages of 580–590 Ma. Fourth, the Sarn Complex in Llyn comprises metagabbros and granite rocks which occur to the south-east of the Llyn Shear Zone (LSZ), a continuation of the MSFS, which separates these igneous rocks from low-grade Monian *mélange* to the north-west. A late Precambrian zircon magmatic age of 615 ± 2 Ma has been obtained from a metagabbro of the LSZ. Fifth, on the mainland of north-west Wales, the Arfon Group comprises a thick sequence of tuffs and volcanoclastic rocks, dated at 614 ± 2 Ma, which are conformably overlain by late Lower Cambrian siltstones. Correlatives of the Arfon Group may occur as isolated outliers on Anglesey and, if proven, would provide an important potential lithostratigraphical link across the MSFS. The stratigraphical correlation between the various units has proved highly controversial. The recent recognition of mylonitic rocks, for example in the LSZ, emphasises the presence of tectonic contacts and indicates that each component may represent a so-called 'suspect terrane' which was transported laterally into position along the major faults and shear zones.

Ongoing unpublished research suggests, that Anglesey's Precambrian rocks accumulated in accretionary prisms, providing a tectonic sequence rather than a stratigraphic sequence which was formerly accepted. This new research

would reverse the accepted stratigraphic order established for the island. This Precambrian basement later formed the north-west margin of the Lower Palaeozoic Basin, the initiation of which was contemporaneous with Arfon Group volcanism. The timing of the inferred fault displacements has also been the subject of debate. Investigations on Llŷn have demonstrated that assembly of the basement terranes was completed at least by early Ordovician times since an unconformable Arenig overstep sequence has been identified at several localities such as Wig Bach, Parwyd and Mountain Cottage Quarry. The Arenig sequence of Anglesey and Llŷn is considerably less deformed and metamorphosed than the underlying basement, although this distinction is not everywhere obvious. To select RIGS to demonstrate the Precambrian evolution of Anglesey and Llŷn, three separate networks were devised. These are: 1. Precambrian stratigraphy and structures. This network includes two sub-sets: a) Precambrian sedimentary structures; and b) tectonic structures, such as folds and faults, which may have occurred during a tectonic event in Precambrian times or later, for example, during the Caledonian Orogeny; 2. Precambrian palaeontology which includes any life-form and trace fossil, such as stromatolites, sponge spicules, worm burrows and bioturbated metasediments. Current research suggests that some of these fossils may be Cambrian or even Ordovician in age, but as these life-forms were previously held to be Precambrian in age, they have been included in this category; and 3. Precambrian reference sections. These aim to represent all important Precambrian rock types found in Anglesey and Llŷn. They include the major mapped units of Greenly (1920). The aim is to provide the best and most accessible exposure of the rock type. These can be considered as RIGS 'type sections'. Where there is a relevant mineralogical, sedimentary, structural or other change across an outcrop, several representative sites have been chosen.

Network context of the site: Gwalchmai is a critical component of a network of three proposed GCR sites and two RIGS that demonstrate key features of the Precambrian Coedana Complex of Anglesey. The Coedana Complex comprises three components, namely the Coedana Granite (represented by Gwalchmai proposed GCR site), hornfels (represented by Maen-Gwyn proposed GCR site) and high-grade metamorphic rocks known as the Central Anglesey Gneisses (represented by the Tyddyn Gyrfer proposed GCR site). The accessible outcrop on Porth Nobla Beach and Llys Dulas Coastal Section, which includes iron deposits in the surrounding country rock have been included in this network. At Trwyn Cwmrwd, to the north of Dulas Bay, in addition to the sillimanite, garnet-rich eastern boundary of the granite intrusion, iron pyrites-rich deposits, derived from liquids and gases given out from the granite mass, during the latter stages of crystallisation, are present. The Coedana Granite developed within the Avalonian volcanic arc and was moved into its present position by sinistral strike-slip movements along the Central Anglesey Shear Zone. Emplacement of the granite appears to post-date an earlier phase of ductile deformation recorded in metasedimentary hornfels that occurs both as country rock to the granite and as xenolithic masses within the intrusion. The Central Anglesey Gneisses form the largest outcrop of paragneisses and amphibolite in southern Britain and record a phase of upper amphibolite facies metamorphism. The age of this metamorphism and the relationship between the gneisses and other components of the Coedana Complex currently remain unconstrained although isotopic data support a correlation with the Rosslare Complex of south-east Ireland and provide evidence for an extension of the Coedana Complex across the southern Irish Sea. Collectively, therefore, this network of sites provides important information relating to sedimentation, intrusive igneous activity and deformation in the Monian Composite Terrane and thereby contributes to a greater understanding of the late Precambrian evolution of the Avalonian volcanic arc.

In this study Gwalchmai Quarry belongs to Network 3 (Precambrian reference sections; see above) and has been chosen to demonstrate important characteristics and variations within the Coedana Granite Complex (CGC). The CGC, which covers an area of 30km², has 5 RIGS: i) Porth Nobla shows a fine-grained granite at the western margin of the main outcrop and its associated hornfels; ii) Trwyn Cwmrwd at the eastern end of the outcrop illustrates a variation in the CGC where the rock contains sillimanite, extensive pneumatolitic deposits and alteration to the surrounding country rock; iii) Gwalchmai at the centre of the intrusion represents a coarsely-crystalline facies; iv) Tyddyn Gyrfer shows high-grade metamorphosed gneiss; and v) Maen Gwyn Farm illustrates low-grade metamorphic hornfels.

References:

CARNEY, J.N., HORÁK, J.M., PHARAOH, T.C., GIBBONS, W., WILSON, D., BARCLAY, W.J., BEVINS, R.E, COPE, J.C.W. & FORD, T.D. (2000) Precambrian Rocks of England and Wales. Geological Conservation Review Series No. 20. JNCC, Peterborough, 252pp.

DAVIES, G.R. GLEDHILL, A. & HAWKESWORTH, C. (1985). Upper crustal recycling in southern Britain: evidence from Nd and Sr isotopes. *Earth and Planetary Science Letters*, 75, 1–12.

GREENLY, E. (1919). *The geology of Anglesey*. Memoirs of the Geological Survey of Great Britain. HMSO, London, 980pp. (2 vols)

GREENLY, E. (1920). 1:50,000 (and 1 inch to 1 mile) Geological Map of Anglesey. Geological Survey of Great Britain, Special Sheet No. 92 and (93 with parts of 94, 105 and 106).

HORAK, J.M. (1993). *The late Precambrian Coedana and Sarn Complexes, NW Wales – a geochemical and petrological study*. Unpublished PhD thesis, University of Wales.

TUCKER, R.D. & PHARAOH, T.C. (1991). U-Pb zircon ages for Late Precambrian igneous rocks in southern Britain. *Journal of the Geological Society of London*, 148, 435–43.