Newborough Forest RIGS Site

NRW RIGS no. 148 [SH 39495 64190]

GeoMôn Global Geopark original webpage

RIGS Statement of Interest:

Newborough Forest RIGS Site exposes the best-formed, and preserved, examples of ancient pillow lavas to be found anywhere in Britain. The pillow lavas and their associated jasper (deep sea chert) and breccias are deep sea rocks which formed at a constructive plate margin in similar circumstances to the rocks being extruded today at the Mid-Atlantic Ridge. Such plate margins occur at ‘hot spots’ where ascending warm currents carry lava to the oceanic surface. The lava is extruded as small pulses and the effect of the surrounding cold water on the lava is to solidify them immediately in a pillow shape, Continuous pulses of lava, causes the pillows to land on previous ones and they become welded together. As volcanic material continues to be produced it is pushed sideways and crosses the ocean floor, where it eventually meets with a descending current at a destructive margin. As such, these rocks represent slices of ocean floor, and have been shown to possess the geochemistry of deep sea basalt encased in iron-rich siliceous ocean-floor sediments. Their current location is explained by them having been part of a deformed wedge of sediments and pillow lavas, scraped off the descending plate in an oceanic trench. The pillows then became accreted on to the margin of the continental crust. They are part of a tectonic, rather than a stratigraphic sequence.

Geological setting/context: The Precambrian basement rocks of Anglesey and south-west Ll■n 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 Ll■n 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 ± 4Ma. 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 580–590Ma. Fourth, the Sarn Complex in Ll■n comprises metagabbros and granite rocks which occur to the south-east of the Ll■n 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 ± 2Ma 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 volcaniclastic rocks, dated at 614 ± 2Ma, 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 of the bedded succession, since the first (oldest) material to be accreted lies above later accreted material and thus reverses the age relationships for the South Stack Group, the New Harbour Group and the Gwna Group established for the island by Robert Shackleton. This Precambrian basement later formed the north-west margin of the Lower Palaeozoic Basin, the initiation of which was contemporaneous with Arfon basement terranes and 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 Ll■n is considerably less deformed and metamorphosed than the underlying basement, although this

distinction is not everywhere obvious.

Network context of the site: Newborough Forest is a critical component of a network of three RIGS which represent pillow lavas and demonstrate key features of Greenly's Precambrian rocks in Anglesey. Two further sites demonstrate traces of pillow lavas in glaucophane schists and are described in the latter category. Porth Dinllaen and Mynydd Carreg also belong to the pillow lava category of Precambrian Reference sites but are located in Lleyn.. The pillow lavas in Newborough Forest, form a ridge and extend south-westwards onto the foreshore of Llanddwyn Beach. The rocks comprise fine-grained, well-formed pillows which, although once horizontal, have been rotated into a vertical attitude. Probably, this occurred at the time the spilites were accreted onto the hanging wall of the Monian subduction trench. The pillows young to the south-east and contain vacuoles once filled by zeolites. They exhibit cooled glassy or fine-grained margins with their tops well-rounded and the bases conforming to the shape of the pillows below. This locality is important for demonstrating the effect of cooling on hot lavas in cold water and the nature of the sediments into which the lava erupted. They are also some of the best-formed pillows in Britain. The geochemistry of these basic rocks shows that they were originally mid-ocean-ridge-basalt (MORB), representing a slice of Precambrian oceanic crust. The fresh lavas were subducted into oceanic trenches along destructive plate margins, where 'cold' rocks were quickly buried preserving their pillowed forms and with some subjected to metamorphic pressure and to hydrothermal alteration in others. At this location, the spilites are in regional, unconformable or tectonic contact with the Gwna Group Mélange and are interpreted as having belonged to a Precambrian accretionary prism. It is possible that all Precambrian rocks in southern Britain were part of the same Avalonian subduction system as Nova Scotia, Newfoundland and Canada. Apart from the spilite (pillow lava) in the forest and some appearing from beneath the dunes on the foreshore, other exposures on the margins of Llanddwyn Island are included in a GCR site, Llanddwyn Island (Greenly's Gwna Group). Four other 'pillow lava' RIGS in Anglesey have been chosen because they show variations in their mineralogy or Group within the Precambrian. Firstly, Cliperau (New Harbour Group) on the north Anglesey coast, demonstrates pillows that have been altered by regional metamorphism, Secondly, Porth Trefadog, in Greenly's Skerries Group represents pillows that have been subjected to hydrothermal alteration at a possible 'smoker' on the ocean floor. Castellior Farm and Pentraeth Road Cutting (both in Greenly's Gwna Group) now termed the Eastern Schist Zone (Penmynydd) are examples of pillows that have suffered regional metamorphism and are transitional to the glaucophane schists (pillow lavas subjected to intense pressures at low temperatures) to which they have been altered. Both of the latter two sites exhibit traces of their original pillow form and therefore are important research and educational sites. Mynydd Llwydiarth a short distance from the road cutting is overgrown by dense forest vegetation and will be written up as a glaucophane schist site, when or if, a forest clearance programme re-exposes the rock. Without close examination, it is not known if the exposures exhibit traces of the original pillows which would also place them in the spilite category. Castellior Farm and Pentraeth Road Cutting have a dual interest as they belong to two Precambrian Reference Section sub-groups, glaucophane schists and spilites (pillow lavas). Therefore, only one report for each of the two sites has been written.

To select RIGS to demonstrate the Precambrian evolution of Anglesey and Ll■n, 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. Some current research suggests that some of these fossils may be Cambrian or even Ordovician in age,although other geologists dispute this. 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 of the important Precambrian rock types found in Anglesey and Ll■n. 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 metamorphic, mineralogical, sedimentary, structural or other change across an outcrop, several representative sites have been chosen. In this study, Newborough Forest belongs to Network 3 (RIGS Precambrian reference sections; see above) and has been chosen to demonstrate important characteristics and variations of spilitic pillow lavas, in particular, the effects of cooling in an aqueous environment.

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Site geometry: Site boundary