
Holyhead coastal RIGS site

NRW RIGS no. 287 [SH 23146 83698]

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RIGS Statement of Interest:

This site stretches from Holyhead Mountain to the Breakwater including the Quartzite Formation, South Stack Group and New Harbour Group. The “Rocky Coast” of the Breakwater Park.

This composite site stretches from the Holyhead Quartzite Formation which forms the Headland to the west of Breakwater Park, passing over the other rocks of the South Stack Group and finally to the mica-schists of the New Harbour Group at the Breakwater in Holyhead Harbour to the east. It includes the important worm burrows to be found in the meta-sandstones in the cliffs and hillsides in this area. The rocks have been regionally metamorphosed and faulting and thrusting is well displayed along the entire section. In addition, the chemical and physical weathering along the coast has resulted in stacks and an arch as well as many sections of wave-cut platforms interrupted by the many faults and thrust planes to be found in the section. During the Tertiary Era, basaltic lava was injected into the rocks and a spectacular dyke can be seen in Porth Namarch which displays magnificent spheroidal weathering. The western side of this small inlet displays an excellent example of a thrust fault with mylonisation occurring at the base of the thrust.

Geological setting/context: The Precambrian basement rocks of Anglesey and south-west Llŷn 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 Llŷn 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 $614 \pm 4\text{Ma}$. 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 580–590Ma. Fourth, the Sarn Complex in Llŷn comprises metagabbros and granite rocks which occur to the south-east of the Llŷn 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 $615 \pm 2\text{Ma}$ 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 $614 \pm 2\text{Ma}$, 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 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 Llyn is considerably less deformed and metamorphosed than the underlying basement, although this distinction is not everywhere obvious.

Network context of the site: Holyhead Coastal Section RIGS lies on northern side of South Stack Island and starts in the cliff section to the west of Breakwater Quarry with its Holyhead Quartzite Formation and passes eastwards into the New Harbour Group of rocks, thus providing a strong contrast between the white, very hard quartzite and the shimmering, much-folded green mica schists of the New Harbour Formation. It provides a reference section for both formations as well as having additional, non-Precambrian interests. It is possible that all Precambrian rocks in southern Britain were part of the same Avalonian subduction system as Nova Scotia, Newfoundland and Canada.

The environment in which the life forms existed. During Precambrian times, oxygen levels in the Earth's atmosphere were less than 1%, the critical level for the start of evolution on a vast scale when macrofossils entered the equation. Thus, all types of life had to exist in the sea. By Cambrian times, this critical level had been reached and there was a burst of life and a great variety of organisms evolved. Precambrian fossils were, in the main, bacteria or algae and diverse forms reflected their location, such as deep sea, associated with underwater volcanic eruptions or shallow water and intertidal conditions. The organisms could either be attached to a substrate or free-floating.

The Palaeogeography and climate. During Precambrian times, proto-Anglesey would have been part of the super continent of Pangaea, located somewhere in the region of present day Australia. Later Pangaea split into Gondwanaland and Laurasia and proto Anglesey which was attached to the ancient rocks of western North America became part of the northward-moving continent of Laurasia. The climate in Precambrian times would have been relatively cool compared to the equatorial climate experienced around 300 million years ago which was preceded and succeeded by the tropical climate experienced 100 million years either side of the Carboniferous Period. On its journey northwards it would have experienced two orogenies and one prolonged period of regional metamorphism in late Precambrian times. In addition it would, have been affected by 'Snowball Earth', a prolonged time of freezing snow and ice cover from 750 million years ago to 600 million years or at least a glacial episode in late Precambrian times. 'Global warming', caused by volcanic eruptions and the build up of methane and carbon dioxide in the atmosphere finally released the Earth from its icy grasp at the end of Precambrian times and was, in no small part, responsible for the burst of life which heralded in the Cambrian, the first period of the Palaeozoic era.

The age of the Precambrian rocks The complexity of these rocks in Anglesey and Llyn, both in their composition and tectonic history, has led to great discrepancies in age dating. Normally, rocks are dated by the fossil content or by geochemical analysis using radioactive decay methods. Precambrian fossils are rare and can give general comparative dates. It was not until the stromatolitic sequence at Cemaes Bay was first dated that this was possible in Anglesey. Later work has found other datable fossils in the cherts of Llanddwyn and the worm casts of South Stack but, much of the work has still to be verified because different workers have produced very different dates for the same rocks. Isotope analyses have produced more accurate dates and particularly Rb/Sr and U/Pb analyses from zircons have proved useful. Collins and Buchanan have found early Cambrian ages for the South Stack Group of rocks, thought originally by Shackleton and later workers to be the oldest of the Monian deposits in the sedimentary sequence. These workers had the South Stack Group as the oldest, succeeded by the New Harbour Group and the Gwna Group as the youngest on top. Most recently, Horak (pre-publication research) has dated the limestone olistoliths in the Gwna Melange as between 650 and 700 million years old, making the Gwna the oldest Group on Anglesey, as Greenly had said in 1919. This is in agreement with Windley et. al., (in the press) who have proposed a tectonic sequence, rather than sedimentary sequence as previously proposed. This involves ocean floor sediments and rocks descending into a subduction zone and becoming accreted onto the inner continental wall. These deposits were succeeded by rocks and sediments beneath the accreted 'prisms'. Thus, unlike a sedimentary sequence where rocks are laid on top of each other, tectonically accreted rocks young down the sequence.

Holyhead Coastal Section RIGS Apart from this site and the nearby South Stack RIGS, other sites demonstrating different features in the same formations are included in Precambrian reference sites for their stratigraphical or palaeontological interests.

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, bacteria, 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 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 metamorphic, mineralogical, sedimentary, structural or other change across an outcrop, several representative sites have been chosen. In this study, Holyhead Coastal Section RIGS belongs to Network 1 & 3 (RIGS Precambrian Stratigraphy and Structures; Precambrian reference sections; see above).

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Section B

PRACTICAL CONSIDERATIONS: Accessibility: The site is located on the north coast of Holy Island and is easily reached from the port area of Holyhead by following the coast road west until a narrow road can be seen on the left, signposted Breakwater Country Park. It is possible to park about 4 cars in a parking area alongside the road by the 'bond' warehouse or by travelling into Breakwater Park car park at the other end of the site. Safety: The coastal cliffs here are fairly high and precipitous, with cliff areas especially dissected and uneven especially near to the stack and arch. However, dangerous areas do have barriers across them and the coastal path allows access to see all the relevant features apart from the exposures at Porth Namarch. Currently, there is no access down into Porth Namarch apart from a muddy, slippery path down to the beach. Conservation status: It lies in Anglesey's AONB and Heritage Coast and is crossed by Anglesey's Coastal Footpath.

Site geometry: Site boundary