Porth Dafarch RIGS Site

NRW RIGS no. 398 [SH 23374 79904]

GeoMôn Global Geopark original webpage

RIGS Statement of Interest:

Porth Dafarch RIGS Site provides an accessible location where some of the important features of Tertiary igneous dykes can be demonstrated. The geomorphic expression of the dyke, as a depression between the harder outcrops of the New Harbour Group is particularly clear on the south side of the beach around 23517965. The better quality of soils developed on the dyke is also evident at this location. The left-stepping offset of the dyke seen between the NW and SE sides of the beach is apparently due to “en echelon” relationships rather than to strike-slip displacement of the dyke, since no comparable displacement is mapped across the North Stack fault that lies immediately inland. Support for this interpretation can be seen around on the cliffs around 23357982, where the continuation of the major planes of weakness that the dyke on the NW side of the beach apparently followed can be seen. This question of whether the Tertiary dykes have been offset by strike-slip movements has been an important and contentious issue that these outcrops help resolve.

Geological setting/context: Anglesey is the only part of Britain south of Scotland that shows a significant number of geologically young (Tertiary) igneous dyke intrusions and much older (Palaeozoic) igneous dykes in close proximity. The dyke swarms of Anglesey have played a key role in the history of geology. This was one of the first places in the world where the nature of igneous intrusions, and their thermal effect on surrounding rocks, was documented. This work was published in 1822 by John Stevens Henslow as part of a little-known but remarkably insightful piece of geological mapping. Henslow was the Cambridge mentor for the young Charles Darwin. Geological fieldwork in North Wales introduced Charles Darwin to new geological concepts, including the enormity of geological time, which helped Darwin develop the theory of evolution. Anglesey again set a world class standard for geological mapping in 1919, when the British Geological Survey published a detailed geological map by Greenly, which continues to be used to the present day. Greenly noted that many of the dykes mapped by Henslow were not visible, having been quarried out or buried by land-fill in the intervening hundred years. It was only in 1996, when airborne magnetic surveys conducted for oil and gas exploration were published, that the existence of some of Henslow’s missing dykes could be confirmed. This illustrates the particular sensitivity of dyke sites to loss, and emphasises the need to preserve those key sites that remain. The dykes of Anglesey are now known to include two main groups. One poorly understood group is associated with the Caledonian Orogeny that gave much of the folding and faulting seen in Snowdonia. It seems likely that this interval, some 350–500 million years old, encompasses several discrete phases of dyke injection, but insufficient scientific work has yet been done to clearly define these separate events. The second set, some 40–60 million years old, was caused by the plate tectonic stresses and igneous activity associated with the onset of rifting and continental drift which led to formation of the North Atlantic Ocean. This younger set is part of the same phase of igneous activity that formed the columnar basalt “Giants Causeway” of Ireland. The dykes of Anglesey represent a potentially rich source of geological data that is not available elsewhere in Wales and England. The dykes can be dated radiometrically, and the orientation of the dykes and the nature of the intrusive displacements can be measured. From these observations the state of stress in the Earth’s crust during intrusion can be deduced. The temperatures in the Earth’s interior can be inferred from the dyke rock chemistry and mineralogy. This in turn means that data from the Anglesey dykes will enhance our knowledge of the Plate Tectonic evolution of western Britain. The regional heating associated with the younger dyke swarm may have “cooked” organic-rich sediments to yield the oil and gas now exploited off North Wales, and may have helped formed some mineral deposits such as the copper at the Great Orme. The associated changes deep beneath the Earth’s crust, and the tectonic stresses associated with rifting and continental drift, contributed to the crustal uplift which has created the mountains of Snowdonia. The underlying mechanisms that trigger the modern earthquakes in North Wales are poorly understood. The geometries of the younger dykes suggest that the magma was intruded up NW–SE fissures in the Earth’s crust, which dilated in response to NW–SE compression. Analysis of earthquakes shows that North Wales continues to be affected by NW–SE compressive stresses – so study of the dykes may help shed some light on our modern earthquakes. In summary, the dyke swarms of Anglesey need to be preserved for their significance in the

historical development of geology, as educational localities, and for continued research of both academic and economic significance.

Network context of the site: In selecting RIGS to demonstrate the Tertiary igneous characteristic of Anglesey, two separate networks were devised. With practice, it is possible to discriminate Tertiary dykes from Palaeozoic dykes at outcrop. However, it is useful to identify sites where the intrusions can be demonstrated unambiguously at outcrop to be post-Palaeozoic in age. Consequently two networks are developed: 1. Tertiary intrusions into the Carboniferous and younger sequences; 2. Tertiary intrusions into pre-Carboniferous sequences. Porth Dafarch belongs to Igneous Network 2. Tertiary intrusions into pre-Carboniferous sequences.

References:

HENSLOW, J.S. 1822. Geological Description of Anglesea. Transactions of the Cambridge Philosophical Society, 1, 359–452.

HARKER, A. 1887. Woodwardian Museum notes: on some Anglesey dykes. I & II Geological Magazine, 409–416, 546–552.

HARKER, A. 1888. Woodwardian Museum notes: on some Anglesey dykes. III. Geological Magazine, 267–272.

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

MORTON, A.C. & PARSON, L.M. (eds) 1988. Early Tertiary Volcanism and the Opening of the NE Atlantic. Geological Society London Special Publication, 39.

DEWEY, J.F. & WINDLEY, B.F. (1988). Palaeocene-Oligocene tectonics of NW Europe. In: Early Tertiary Volcanism and the Opening of the NE Atlantic. Geological Society London Special Publication, 39, 25–31.

BEVINS, R.E., HORAK, J.M., EVANS, A.D. & MORGAN R. 1996. Palaeogene dyke swarm, NW Wales: evidence for Cenozoic sinistral fault movement. Journal of the Geological Society, London, 153, 177–180.

MADDOCK, R.H., ASPINALL, W.P., HAILWOOD, E.A., TING FUNG & RUTTER, E.H. 1997. Discussion on Palaeogene dyke swarm, NW Wales: evidence for Cenozoic sinistral fault movement. Journal of the Geological Society, London, 154, 373–374.

MEADOWS, N.S., TRUEBLOOD, S.P., HARDMANN, M. & COWAN, G. (eds) 1997. The Petroleum Geology of the Irish Sea and Adjacent Areas. Geological Society London Special Publication, 124.

SHANNON, P.M., HAUGHTON, P.D.W. & CORCORAN, D.V. (eds) 2001. The Petroleum Exploration of Ireland’s Offshore Basins. Geological Society London Special Publication, 188.

Site geometry: Site boundary