Porth y Mor RIGS site

NRW RIGS no. 424 [SH 49340 88196]

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RIGS Statement of Interest:

Porth y Mor RIGS sites is the type section of Porth y Mor Formation of thr Anglesey Old Red Sandstone succession, a sequence comprising fluvial fining upwards cycles with epsilon cross-bedding, intraformational conglomerates and calcretes. These strata form part of a folded and cleaved Anglesey Old Red Sandstone succession unique within North Wales. Sited over 100 km north-west of the nearest Old Red Sandstone outcrop in the Welsh Borderland, the Anglesey succession provides an important constraint on late Silurian to early Devonian palaeogeographical reconstruction, and on the timing and nature of late Caledonian orogenic events. Moreover, J. R. L. Allen's seminal sedimentological study of this succession, published in 1965, established many of the key features of fluvial depositional models and calcrete formation. In this context, the Porth y Mor site is particularly important as the section where Allen first recognized and interpreted epsilon cross-bedding. The section in the Porth y Mor Formation commences on the south side of Traeth yr Ora and dips consistently to the south at about 27°. The contact with the underlying Traeth Bach Formation is concealed beneath the beach to the north. The exposed succession, about 225 m thick, comprises a series of fining-upwards cycles. Allen (1965) recognised 43 cycles, each constructed of a lower conglomerate and sandstone and an upper muddy siltstone. Calcareous nodules (glaebules) are common throughout the siltstone units and locally form the dominant element, coalescing to form continuous beds of impure limestone and dolomite calcrete. At the base of the lowest exposed Porth-y Mor Formation cycle is 3.4 m unit of conglomerate composed of clasts local Precambrian and Lower Palaeozoic rock types. This 'exotic' conglomerate contrasts with the intraformational conglomerates, which occupy the bases of most of the remaining cycles and are composed of rounded pebbles and granules of red and green siltstone, fine-grained, red sandstone and limestone, as well as reworked calcareous nodules. These latter conglomerate beds record the reworking of Old Red Sandstone sediments from elsewhere within the basin of deposition. In every cycle, the basal conglomerate grades upwards into a much thicker, fining-upwards sandstone unit. The coarser lower sandstones and basal conglomerates commonly exhibit large-scale tabular or trough cross-bedding in sets up to 0.45 m thick. In contrast, the overlying finer grained sandstones are characterised by small scale cross-lamination and planar-laminated intervals.

In ten of the Porth y Mor Formation cycles, the basal sandstone and conglomerate unit exhibits a distinctive set of shallow-dipping sigmoidal bedding surfaces. This pattern of bedding surfaces is epsilon cross-bedding (Allen, 1963; 1965). The surfaces cross-cut the vertical lithological changes within the conglomerate and sandstone units, but upwards-fining and the upward succession of tractional structures seen in the cycles overall is visible within each cross-bed of the epsilon sets. Critically, palaeocurrent directions indicated by the internal tractional features show that current flow was consistently parallel to the strike of the epsilon cross-bedding surfaces. The latter dip predominantly towards the east, but epsilon cross-sets with either westerly or southerly dipping surfaces are also present in the section. Palaeocurrent indicators in the Porth y Mor Formation show that depositing currents largely flowed from the north-east. Sparse trace fossils, including arthropod tracks, are recorded, but no body fossils have yet been discovered. Allen's (1965) synthesis of the sedimentary processes and depositional environment of the Anglesey Old Red Sandstone succession was an important early study of fluvial sedimentology. Succeeding the playa lake deposits of the Traeth Bach Formation (RIGS JRD 1), the cyclical Porth y Mor Formation records the subsequent establishment of a broad meandering river belt and floodplain. The conglomerate and sandstone units of the Porth y Mor cycles represent the river channel deposits. The pattern of upward-fining above a basal erosion surface and the associated succession of sedimentary structures are consistent with deposition on the laterally migrating point bars of meandering streams. However, the Porth y Mor Formation is particularly noteworthy in being the first rocks in the stratigraphical record in which the origin and significance of epsilon cross-bedding were first recognised. Allen (1965) demonstrated that the sigmoidal surfaces, dipping perpendicular to the flow direction shown by associated tractional structures, represent the surfaces of meander point bars, and therefore, that each epsilon cross-set records the process of point bar lateral accretion. At a

time when the understanding of ancient sedimentary, fluvial fining-upwards units was in its infancy, the discovery and interpretation of these features showed that they were the products of laterally migrating, meandering channels of mixed bedload rivers (Allen, 1965, 1970). On the basis that the thickness of the epsilon cross-sets should correspond to the bankfull depth of the channel in which they were deposited, Allen (1965) estimated that the rivers which supplied the sediment of the Porth y Mor Formation were likely to be at least 60 km long and 20 m wide, and perhaps up to 600 km long and 90 m wide. The upper siltstones of the Porth y Mor cycles record the accumulation of fine-grained, overbank sediment on extensive river floodplains. The calcareous nodules and limestone and dolomite beds display many of the features of modern calcretes and dolocretes. As in the underlying Traeth Bach Formation, these lithologies record the diagenetic growth of carbonate within soil profiles during periods of prolonged subaerial exposure in a semi-arid climate (Allen, 1974a).

Geological setting/context: Allen (1965) viewed the Anglesey Old Red Sandstone succession as lying at the margin of a broad depositional tract connected to the main Old Red Sandstone basin to the south, supplied with sediment sourced some distance to the north-west by south-easterly flowing rivers; and this interpretation has since been endorsed (Allen (1974b; Allen and Crowley, 1983; Bluck et al., 1992). In the absence of fossil or other direct dating evidence, the age of the Porth y Mor Formation remains unproven, but the folded and cleaved nature of the Anglesey Old Red Sandstone succession persuaded Allen (1965) that these rocks were likely to range from late Silurian to early Devonian (see RIGS JRD 1).

Network context of the site: The Porth y Mor site is one of a network of four RIGS selected to represent the Anglesey Old Red Sandstone succession.

References:

Allen, J R L. (1963) The classification of cross-stratified units, with notes on their origin. Sedimentology, 2, 93–114.

Allen, J.R.L. (1965) The sedimentation and palaeogeography of the Old Red Sandstone of Anglesey, North Wales. Proceedings of the Yorkshire Geological Society, 35, 139–185.

Allen, J.R.L. (1970) Studies in fluviatile sedimentation: a comparison of fining-upwards cyclothems, with special reference to coarse-member composition and interpretation. Journal of Sedimentary Petrology, 40, 298–323.

Allen, J.R.L. (1974a) Studies in fluviatile sedimentation: implications of pedogenic carbonate units, Lower Old Red Sandstone, Anglo-Welsh outcrop. Geological Journal, 9, 181–208.

Allen, J.R.L. (1974b) The Devonian rocks of Wales and the Welsh Borderland. In The Upper Palaeozoic and post-Palaeozoic rocks of Wales. (ed T. R. Owen), Cardiff: University of Wales Press, pp. 47–84.

Allen, J.R.L. and Crowley, S.F. (1983)Lower Old Red Sandstone fluvial dispersal systems in the British Isles. Transactions of the Royal Society of Edinburgh, Earth Sciences, 74, 61–68.

Bluck, B.J., Cope, J.C.W. and Scrutton, C.T. (1992) Devonian. In Atlas of Palaeogeography and Lithofacies. (eds J. C. W. Cope, J. K. Ingham and P.F. Rawson). Memoir of the Geological Society, London, 13, pp. 57–66.

Site geometry: Site boundary