Red Wharf Bay RIGS

NRW RIGS no. 384 [Trwyn Dwlban] [SH 53216 81988]

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RIGS Statement of Interest:

The Red Wharf Bay RIGS provides a unique section through the upper part of the Anglesey Dinantian succession (Red Wharf Limestone Formation). It includes the famous sandstone pipe exposures south of Trwyn Dwlban and their associated conglomerate-filled fluvial channel features, but also a higher horizon of giant sandstone pipes. The base of a capping sequence of bedded cherts may mark the position of the local Dinantian – Namurian boundary. The Anglesey succession as a whole records the progressive growth of a carbonate platform during a pulsed Dinantian transgression. The late Asbian to Brigantian sequence is constructed from a series of shoaling upwards carbonate cycles each capped by a palaeokarstic surface formed during periods of prolonged subaerial exposure of the platform surface (see RIGS JRD 6 and 7; Davies, 1991).

In North Wales, clastic sequences infilling fluvially channels incised during these periods of emergence, are a feature unique to the Anglesey Dinantian succession. Sandstone-filled pipes are preserved along the margins of several of these channels (see RIGS JRD 7 and 8), however, it was relationships observed at the Red Wharf Bay RIGS which proved critical in developing a model for their formation and fill; and which revealed the potentially complex and polyphase nature of intra-channel erosional and depositional events. The site extends the GCR site described by Adams and Cossey (2004), and provides opportunity for additional descriptive and interpretative detail. Reefs exposed at low tide at the northern end of the section [SH 5316 8213] reveal quartz and lithic pebble conglomerates infilling a channel incised into limestones of the underlying cycle. The channel is 7 to 8 m deep at this point. Traced southwards it is clear that this feature and its clastic fill – the Dwlban Sandstone – are related to the much thinner sequence of tributary channel and pipe infilling conglomerate and sandstone exposed at Trwyn Dwlban [SH 5325 8189].

The sandstone pipes famously exposed at this locality have been described by numerous previous authors notably Greenly (1901, 1919), Baughen and Walsh (1980), and, in the greatest detail, by Walkden and Davies (1984). The latter authors recognized three separate phases of pipe development and that the later phases cut the earlier ones. The pipes and associated channel features were recognized as occurring at the boundary between two Brigantian shoaling-upwards carbonate cycles and, hence, to have formed during a period of marine regression leading to subaerial exposure of the local carbonate platform. The channels, as elsewhere (see RIGS JRD 8), record fluvial incision by fresh water streams and the pipes were recognized as sited on the terraced margin of these features. The over-steepened attitude of bedding surfaces within the pipe-filling sandstone plugs proved to Walkden and Davies (1984) that the pipes were the product of dissolution of already lithified limestone at the top of the underlying cycle, but that an overlying unlithified sand bed was already in place above this surface. As the pipe grew in width and depth, the overlying sand was steadily let down to fill the developing cylindrical hollow. Dissolution was achieved by downward percolating ground waters within the vadose zone consistent with the depression of the local water table along the margins of the channels. The polyphase nature of pipe development at the site shows not only that there were at least three periods of dissolution beneath a sand cover, but that in between each of these events the sand within the preceding generation of pipes had been cemented and lithified. This serves to underline the complexity of the channel in-filling clastic sequences recognized here and elsewhere within the Anglesey Dinantian succession (see RIGS JRD 6 and 7); and of the processes which operated along their margins. This evidence for multiple episodes of incision, intra-channel deposition and lithification may indicate that minor rises and renewed falls in sea level were influencing processes within the confines of the channels, but were not of sufficient magnitude to drown the platform as whole and re-introduce carbonate deposition. Davies (1983) and Walkden and Davies (1984) recognized that, at any one level, the individual channels recognized within the Anglesey succession were branches within a broader anatomizing system of linked channels. Alternatively, or additionally, therefore, complex intra-channel relationships may record the temporary abandonment of a local branch as incision switched to an adjacent site, prior to its subsequent re-excavation.

The upper bed of the Dwlban Sandstone, the source layer for the final set of sandstone pipes, is a bioturbated quartzitic sandstone. It is sharply overlain by dark grey mudstones; aside from Planolites burrows, unfossiliferous for the most part, but with abundant marine brachiopods towards the top. Sharply succeeding these strata is a sequence of irregularly bedded limestones with common chert nodules and locally abundant colonies of the branching coral Lonsdaleia duplicate. This sequence records the final phase of deposition within the Dwlban Sandstone channel, its final drowning and abandonment. Rising sea level initially established an estuarine environment within the confines of the channel. In this setting, the basal sand, probably deposited by fluvial processes, was subsequently colonized and reworked by low-salinity-tolerant burrowing organisms before it was blanketed by estuarine muds. Fully marine conditions entered at the top of the mudstone as sea level rose above the margin of the Dwlban channel, flooded the contemporary platform surface and initiated the next phase of open marine carbonate sedimentation. Cliffs to the south [SH 5321 8172], 2.5 m above the Trwyn Dwlban Sandstone pipe horizon, expose the succeeding Brigantian cycle boundary and the overlying, sheet-like, St. David's Sandstone. This too expands downwards to infill two pipes which are much larger than any of the Trwyn Dwlban examples, ranging up to 3 m in diameter and 5 m in depth. The attitude of bedding traces within the fill of these giant pipes confirms that these features also formed and grew during a further period of platform emergence, in response to dissolution at the base of the overlying sandstone bed, but prior to its lithification. The 21 m of thick-bedded limestones with abundant chert nodules which succeed the St. David's Sandstone record a subsequent phase of platform carbonate deposition. The quarried sides of the rock buttress known as Castell-mawr [SH 531 815] reveal the succeeding Castell-mawr Sandstone at the base of the highest of the Brigantian cycle recognized on Anglesey. Chert nodules are again abundant in these thick-bedded units, but 5 m above the Castell-mawr Sandstone, is the base of a distinctive 6 m-thick sequence of thin-bedded cherts which caps the Castell-mawr feature. Greenly (1919) and subsequently Davies (1983) included this unit in the Dinantian, but research in the Flint district suggests contrary to Warren et al. (1984), that the closely comparable Pentre Chert Formation is earliest Namurian in age (Davies et al., 2004). In thin section, the cherts contain abundant sponge spicules as well as silicified brachiopod and crinoidal remains. The complex processes associated with Carboniferous chert deposition and diagenesis in North Wales are reviewed by Davies et al. (2004). The Pentre Chert Formation, of which the Castell-mawr sequence may be the local representative, records the abandonment of widespread carbonate deposition across the former Dinantian platform and the encroachment of silica-rich basinal deposits across its subsiding margin.

Geological setting/context: The Dinantian succession of North Wales records the evolution and growth of a carbonate platform founded on the older Palaeozoic and Precambrian rocks of the region in response to pulsed, but sustained marine transgression (George, 1958, 1974; Somerville & Strank, 1989; Davies et al., 2004). The Dinantian sequence on Anglesey was deposited during the latter phases of this event, during the Asbian and Brigantian stages. Frequent falls in sea level (forced regressions) characterize this period of time and, as a consequence, the limestone successions on Anglesey, and elsewhere, are constructed from a series of shoaling-upwards sedimentary cycles. The tops of each cycle display features indicative of subaerial exposure, karstification and soil formation (Davies, 1991). However, the Anglesey succession accumulated at the landward margin of the platform and is unique in preserving features and deposits restricted to such a setting. Here, during periods of regression, fresh water streams flowed on to the emergent platform surface and incised deep channels. Distinctive siliciclastic facies accumulated within these channels and their margins display the effects of contemporaneous dissolution. The latter include the distinctive and unique sandstone filled pipes for which the succession is famous. The Red Wharf Bay RIGS exposures were instrumental in the interpretation of these features. They also reveal the complexity of the channel-filling sequences showing that these preserve evidence of additional erosional and depositional events not apparent outside the channel confines. The Red Wharf Bay RIGS is additionally important in providing an complete section through the uppermost part of the Anglesey Dinantian limestone succession and its contact with the overlying Castell-mawr bedded chert sequence. The latter remain undated at this site, but compare closely with strata elsewhere in North Wales (Pentre Chert Formation) now viewed as Namurian in age.

Network context of the site: The site forms one of series of 9 selected to illustrate the Anglesey Dinantian succession and the processes, erosional, depositional and diagenetic, which were active during and subsequent to its accumulation; these in turn from part of a broader network of Upper Palaeozoic RIGS in North Wales.

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