Penrhyn Point to Huslan RIGS

NRW RIGS no. 383 [SH 52074 83926]

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RIGS Statement of Interest:

Penrhyn Point to Huslan RIGS provides sections through the Benllech Sandstone and show the relationship with palaeokarstic surfaces.

Penrhyn Point to Huslan RIGS provides critical sections through the Benllech Sandstone and the two fluvially incised channels it infills, as well as demonstrating the relationship between these channels and contiguous Brigantian carbonate cycles and palaeokarstic surfaces. In North Wales, clastic sequences infilling fluvially incised channels are a feature unique to the Anglesey Dinantian succession and the exposures within this RIGS were crucial in establishing a process-driven model for their formation and fill. 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). To the south of Penrhyn Point are low cliff exposures [SH 5197 8454] in dark, thinly interbedded, argillaceous limestones and mudstone, including the metre thick Penrhyn Coral Bed. Composed of intermeshing, silicified colonial colonies predominantly of the genera Siphonodendron and Diphiphyllum, this bed is an important marker horizon in the local Brigantian succession (Bates and Davies, 1981). To the south, these coral-bearing strata rise to a higher level in the cliffs and beneath them is exposed facies of the Benllech Sandstone.

The cliffs and rock platforms from this point south to Borth Wen [SH 520 840] provide an uninterrupted section through the northern of two channel-filling clastic sequences. In this northern channel, a basal unit of trough cross-bedded conglomerates (Lithofacies A of Davies, 1983) overlies an irregular contact with an underlying limestone sequence. Pebbles in the conglomerates include quartz and variety of lithic clasts, as well as jasper, most clearly derived from the suite of Anglesey Precambrian rocks. Tractional features show that current flow was from the west. The top of the conglomerate unit forms an extensive wave-cut platform above which lies a 5.5 m-thick sequence of interbedded sandstones and silty mudstones with flasser and linsen–bedded intervals (Lithofacies B of Davies, 1983). The sharp bases to the sandstone beds commonly display groove and tool casts. Planar and cross-lamination, including ripple-drift cross-lamination, is widely seen. Bidirectional cross-lamination is locally present in the upper part of some sandstone beds beneath symmetrically rippled marked tops. The sandstone beds vary from tabular and laterally extensive to high lenticular, many wedging out laterally. Cross-cutting channel features are also present. Other sandstones display rootlets, but bioturbated levels with the trace fossils *Planolities*, *Teichichnus* or *Rhizocorallium* are also present. The distinctive tracks of limulids recognized as the trace fossil *Kouphichnium* have also been recorded. The mudstones are commonly rich in carbonaceous debris and blocky levels with abundant carbonaceous filaments resemble seatearths. Rare shelly fossils include non-marine bivalves and gastropods, but the local presence of pectinoid bivalves (*Dunbarella*) and stunted brachiopods point to periodic marine influence. Tractional features in Lithofacies B suggest that current flow was dominantly towards the south-west, though evidence of easterly directed flow is also present. Symmetrical ripple crest are aligned NNW–SSE. The distinctive sequence of brown-weathering calcareous sandstones which caps the Benllech Sandstone sequence in the northern channel (Lithofacies C of Davies 1983) displays trough and low-angle cross-bedding, shell coquinas and pebble lags, as well as vertical escape traces including *Lockeia*. At the top of this sequence is a distinctive 50 cm-thick bed of shelly and crinoidal sandy limestone. These calcareous beds compare closely with those seen in the Helaeth Sandstone (RIGS JRD 6) and Aber Sandstone (RIGS JRD 7) and, as at these sites, they are sharply overlain by strata of the succeeding carbonate cycle. The cliffs at Borth Wen expose the northern margin of the southern Benllech Sandstone channel. The section here, illustrated by Davies (1983), demonstrates the erosive and stepped nature of the contact between the channel-filling clastic deposits and the older, but laterally adjacent limestone units. This is the ‘anomalous junction’ of Greenly (1919, p. 613 and 635). However, the locality is also

noteworthy in preserving evidence of the local collapse of the channel side. A large rotated block of the adjacent limestone sequence sits within the channel-filling sequence. Its association with beds of limestone-clast conglomerate, as well as evidence of disruption of the sandstones and mudstones beneath the block appear to suggest that it slid on to a surface of unlithified sediment when the channel had been only partially filled by sediment and, as such, represents a fossil landslide. To south of this feature the succession of three lithofacies (A, B and C) observed within northern channel is also present in this southern sequence. Here the distinctive crinoidal sandy limestone, noted to the north, but just 35 cm thick, is the sole representative of Lithofacies C. The cliffs and rock platforms near Pen-y-coed [SH 5215 8350] reveal the southern margin of the southern Benllech Sandstone channel. Beds of conglomerate largely composed of rounded and angular limestone blocks and boulders rest on, and pinch out southwards against a terraced surface cut into the underlying limestone cycle. To the south, as far as Huslan [SH 520 831], the palaeokarstic surface through which the Benllech Sandstone channels were incised forms an extensive rock platform. In addition to features typical of such levels (rhizocretions, laminated calcrete crusts; see Davies, 1991), this hummocky surface displays shallow sandstone-filled pits, but critically, hollows in the surface are overlain by a veneer of crinoidal sandy limestone identical to the bed of Lithofacies C observed at the top of both the channel-filling sequences to the north. Of further note at this locality is the presence of orange-weathering ferroan dolomite-filled *Trypanites* borings preserved on the crests of many the palaeokarstic hummocks. The sequence of thinly interbedded limestones and mudstones which succeed this palaeokarstic surface, including the Penrhyn Coral Bed, are the same as those which overlie the channel-filling Benllech Sandstone sequences to the north. A major fault at Huslan upthrows late Asbian limestones to the south. It is clear from the relationships evident in the southern portion of the RIGS, including those at Borth Wen, that the coastal sequences of the Benllech Sandstone occupy channels incised into the lower of two successive Brigantian carbonate cycles. It is the upper of these cycles which contains the Penrhyn Coral Bed and sharply overlies the two channel-filling sequences. Outside the channels the boundary between these cycles is marked by a palaeokarstic surface. This surface records the period of subaerial exposure of the Dinantian platform during which fresh-water streams flowing onto the emergent platform were able to incise the channels which Davies (1983) estimated to range up to 19 m in depth. His inland mapping of the Benllech Sandstone indicates that two features recognized on the coast form part of an anatomizing network of channels incised into the newly emergent platform surface during this emergent interval (cf. Walkden and Davies, 1984). Deposition of the various Benllech Sandstone lithofacies within the channels is thought to record the onset a marine transgression, one of many during the Brigantian, which would eventually drown the channels and the adjacent platform surface (Davies, 1983, 1994). The conglomeratic units which line the base of the Benllech Sandstone channels are interpreted as the deposits of eastward flowing braided steams occupying the channel floors, their deposition within the channels promoted by rising base level. The overlying sequences of interbedded sandstone and mudstone record the slow drowning of the channels. The sedimentary structures and bedforms, together with the evidence of localized plant colonization side by side with units containing marine (or at least brackish) fossils, are all consistent with deposition in an estuarine environment, which palaeocurrent indicators show was in receipt of sediment from both up-channel fluvial sources and seaward barriers and shoals. Subsequently, the capping calcareous sandstone units were deposited as these protective barriers were driven landward across the underlying estuarine flats. The distinctive bed of crinoidal sandy limestone recognized at the top of both channel-filling sequences, and seen veneering the adjacent palaeokarstic surface near Huslan, records the final phase of this process as sea level overtopped the channel margins and swept inland to resubmerge the Dinantian platform. This event was effective in excluding silicicastic contamination and re-introducing a carbonate depositional regime. The extensive colonization of the sea bed by branching colonial corals recored by the Penrhyn Coral Bed within the overlying Brigantian cycle testifies to the efficiency of this process.

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. In providing excellent exposures in the Benllech Sandstone, the Penrhyn Point to Huslan RIGS was critical in the recognition of such channels and in the development of a regional model for their incision and sedimentary infilling (Davies, 1983, 1994; Walkden and Davies, 1984).

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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