Lower Old Red Sandstone, Devonian, Wales

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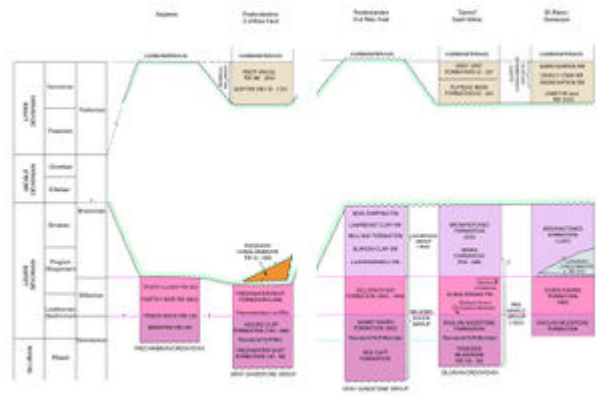
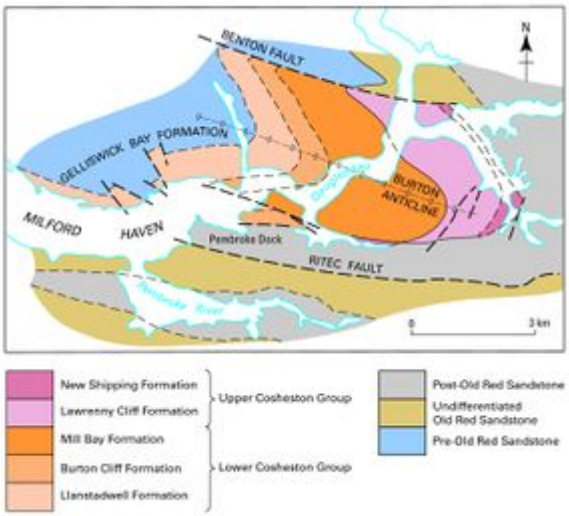


Vertical sections illustrating the Old Red Sandstone of Wales (adapted from Dineley, 1992). Thickness in metres. P916178.

A south-verging fold couplet in the dominantly sandy Milford Haven Group (Old Red Sandstone), St Ann's Head, Dale peninsula. P662421.



Burton anticline north-east of Pembroke dock (adapted from Allen et al., 1982). P916179.

Plateau Beds Formation (Old Red Sandstone), Pen y Fan escarpment, Brecon Beacons. P662422.

Introduction

The base of the Devonian remains imprecisely located in Wales, but is tentatively placed within the uppermost Raglan Mudstone Formation, at a level just above the Bishop's Frome Limestone Member and equivalent strata. The early Devonian Lower Old Red Sandstone comprises an upward-coarsening sequence of alluvial fan deposits.

The succession in south Wales and the Welsh Borders has been subdivided traditionally into three, loosely defined chronostratigraphical stages, which were locally applied because of the difficulty of correlating with the standard European marine stages. These stages are the Downtonian (corresponding largely to the Silurian Přídolí Series), Dittonian (converted to informal lithostratigraphical usage by some authors as the Ditton Group) and Breconian. In terms of the standard Lower Devonian stages, the highest Downtonian, Dittonian and lower Breconian correspond to the Lochkovian Stage, and the rest of the Breconian correlates with the Pragian and Emsian stages (P916178).

Lochkovian

In general, the Lochkovian successions are lithologically comparable with those of the underlying Přídolí Series. However, the Bishop's Frome Limestone Member (see Chapter 5) at the top of the Raglan Mudstone Formation (Přídolí–lowest Lochkovian) marks a major change in basin architecture and facies, indicating a prolonged period of basin shutdown after which more proximal alluvial fan environments replaced the coastal mud flats and marine-influenced alluvial floodplains of the Přídolí. Sandstone increases progressively upwards towards the top of the Lochkovian. The sandstones are typically cross-bedded, with intraclast beds and intraformational erosion surfaces. In addition, they are less micaceous than the sandstones in the Přídolí successions, and their heavy mineral assemblages are not dominated by minerals from a metamorphic terrane, but by clasts and minerals from a dominantly igneous and sedimentary source. It seems clear that the distant northern metamorphic source of the Přídolí was replaced by the sedimentary and igneous rocks of the inverted Lower Palaeozoic basin.

Traditionally referred to the upper part of the Red Marls Group, the Lochkovian successions have been given a plethora of local formational names. The formations are characterised by the arrangement of their component facies in upwards-fining alluvial cycles. Overall, the formations tend to coarsen upwards, the sandstones becoming thicker and more dominant.

Individual cycles commence with the coarsest facies, usually cross-bedded sandstones resting on an erosion surface. The sandstones are predominantly red-brown and purple, but green sandstones occur in places. Lenticular sheets of calcareous intraformational conglomerate, rich in calcrete clasts, locally contain exotic pebbles. The latter are interpreted as the deposits of major distributaries, whereas those conglomerates dominated by calcrete clasts may be the deposits of shallow, ephemeral, flashy streams. Intraformational clasts may also occur at the bases of some sandstone beds. The sandstones, including laterally accreted sheets, are interpreted mainly as the channel deposits of high-sinuosity streams, and the intraformational conglomerates as channel-lag deposits. Flow in many of the channels was probably seasonal. Fish fragments occur in the conglomerates and the sandstones, and provide a biostratigraphical classification (Protopteraspis, Rhinopteraspis crouchi and Althaspis leachi zones), as do microvertebrate fragments. The large cylindrical trace fossil Beaconites is common in the tops of sandstone bodies. Arthropod crawling traces have been recorded in Pembrokeshire and at Pantymaes Quarry near Sennybridge (Diplichnites gouldi), and Tredomen Quarry near Brecon has yielded the traces of fish tails and fins. The fish occur in finer lithologies, and were probably entombed in overbank deposits during flooding.

The sandstones commonly fine upwards into red siltstone overlain by mudstone. Green mudstone also occurs locally, and has yielded plant fragments and miospores. The finer grained lithologies, like those of the underlying Prˆídolí mudrocks, are pedogenically altered, with common calcrete nodules. More mature, massive to rubbly calcrete limestones that occur sporadically in the highest parts of some cycles formed in seasonally wet, arid and semi-arid climates. Pseudoanticlinal, gilgai-type structures can be seen where the calcretes are well exposed. Sandstone-filled desiccation cracks are common at the tops of mudstone units. The fine-grained lithologies were mainly deposited in floodplain environments that were subject to frequent desiccation and calcic soil formation; at least some of the mudstones and siltstones may have originated as windblown dust, and some may have formed as lacustrine deposits in ephemeral floodplain lakes. Some mudstone bodies are interbedded with thin, point bar-type gravelly lenses of calcrete clasts in low-angle cross-bedded sets, and have pelleted fabrics, indicating deposition of pedogenic, pelleted mud aggregates from bedload in small sinuous channels.

Along the north coast of Milford Haven in Pembrokeshire, between the Ritec and Benton faults, the Gelliswick Bay Formation at the top of the Milford Haven Group comprises the thickest development (up to 1500 m) of the upwards-fining alluvial cycles in Wales and the Welsh Borders. Contemporaneous movement along the faults resulted in the deposition of alluvial fans at the basin margins, and introduced marked thickness variations. South of the Ritec Fault (P662420); (P662421), the Freshwater West Formation, up to 580 m thick, consists of the Conigar Pit Sandstone Member and the overlying Rat Island Mudstone Member. The Conigar Pit Sandstone mainly comprises a stacked succession of upward-fining cycles of intraformational conglomerate, sandstone and mudstone with calcrete. The most notable feature of the member at its type locality is the occurrence of eleven sandstone-mudstone lateral accretion complexes. The Rat Island Mudstone Member consists of red calcareous siltstone with abundant nodular calcrete.

To the east, Lochkovian strata (the St Maughans Formation) form the lower part of the prominent scarp features through the Carmarthenshire Fans to the Black Mountains. In Monmouthshire, where the St Maughans Formation was exposed during construction of the M4 motorway tunnel at Newport, the strata are closely comparable with those farther west. Equivalent beds that are well exposed in the Sawdde Gorge have been referred to the Llanddeusant Formation.

The St Maughans and Llanddeusant formations comprise cycles of very fine- to medium-grained, grey, pink and red channel sandstones, fining-upwards and overlain by siltstone and mudstone overbanks deposits, as described above. Complete fish specimens have been discovered in the St Maughans Formation at Cwm Mill near Abergavenny. More mature, massive to rubbly calcrete limestones, such as the Pontypool limestones and the Ffynnon limestones, occur at the top of the St Maughans sequence near Pontypool and in the Black Mountains, respectively. A 15 m-thick, green, channel sandstone complex in the St Maughans Formation at Pantymaes Quarry, south of Sennybridge, may have resulted from transcurrent movement and slight northern uplift of the Carreg Cennen Disturbance. The lithological uniformity of the sequence indicates that, in early Devonian times, south Wales lay within the distal part of a vast, broadly south-facing alluvial plain.

On Anglesey, probable Lochkovian strata crop out southwards from the coast between Dulas Bay and Lligwy Bay inland to near Llangefni. The succession is about 500 m thick, and records the burial of a dissected platform by sediments that were derived from the mountain belt to the north. The correlation and age of the oldest beds, which were deposited in a palaeovalley that was geographically isolated from the Anglo-Welsh succession, are uncertain, but much of the overlying succession is similar to that in south Wales, suggesting stratigraphical and sedimentological continuity. Asymmetric folding and an associated cleavage in the sediments are attributed to the Acadian Orogeny, and support a pre-latest Early Devonian age.

At the base of the succession on Anglesey, the Bodafon Formation comprises up to 45 m of conglomerate and pebbly sandstone with clasts of Precambrian and Ordovician rocks, and constitutes a diachronous, laterally variable facies that drapes the underlying palaeotopography. The formation is interpreted as a series of coalescing alluvial fans that were banked against a north-west-facing slope. The overlying Traeth Bach Formation comprises 130 m of red-brown calcareous siltstone with abundant calcrete nodules, three extraformational conglomerate beds, two intraformational conglomerates and sporadic thin sandstone beds. The siltstones are interpreted as playa lake deposits that were extensively calcretised during frequent episodes of emergence, desiccation and soil formation. The sequence is similar to the Raglan Mudstone Formation in south Wales and its top is similarly marked by the thick mature calcrete. The Porth y Mor Formation, 350 m thick, comprises fining-upwards cycles of conglomerate, sandstone and siltstone, the last containing calcrete nodules. The succession contains examples of laterally accreted sandbodies (recognised by epsilon cross-stratification, first identified here by J R L Allen), and the formation is interpreted as having been deposited in the channels of south-eastward-flowing, meandering

streams and as overbank deposits on their floodplains. Heavy mineral assemblages rich in zircon, tourmaline and rutile, and lithic grains of feldspathic gneiss and quartz-mica schist were sourced either from the local Mona Complex outcrop, or from high-grade Precambrian metamorphic rocks of north-west Scotland. The uppermost Traeth Lligwy Formation is 25 m thick, and consists of thinly bedded, fine-grained, bioturbated sandstone and siltstone, generally lacking in calcrete and conglomerate. Deposition in more permanent lakes is suggested, an environment that is unique to Anglesey in the Lower Devonian of the Anglo-Welsh Basin.

Pragian–Emsian

The Brecon Beacons are the type area of the Breconian local stage, equivalent to the highest Lochkovian and the Pragian and Emsian stages of the standard chronostratigraphical succession. The strata are preserved across the whole of the south Wales outcrop. They are conformable on Lochkovian strata throughout, apart from south of the Ritec Fault in Pembrokeshire, where a thick conglomerate (the Ridgeway Conglomerate Formation) may be at least in part late Lochkovian to Emsian age and may rest unconformably on the Lochkovian Freshwater West Formation.

In Pembrokeshire, north of the Ritec Fault, the Gelliswick Bay Formation passes conformably up into the Cosheston Group. The group is well exposed in Milford Haven, around the easterly closure of the Burton Anticline, north east of Pembroke Dock (P916179). It is characterised by green sandstone, and is correlated with the Senni Formation farther east, but is much thicker (1500 to 1800 m), having been deposited in a zone of active rifting in the hanging wall of the Benton Fault. The group coarsens upwards overall, and is divided into five formations. The lowermost three formations (Llanstadwell, Burton Cliff and Mill Bay formations) comprise predominantly green sandstone with subordinate red sandstone, green intraformational conglomerates and red and green siltstone, all arranged in upward-fining sequences. The uppermost formations (Lawrenny Cliff and New Shipping formations) are similar, but contain coarser grained, red-brown sandstone and conglomerate with a wide variety of sedimentary, intrusive and extrusive igneous and metamorphic clasts. The bed forms and internal sedimentary stuctures have enabled a detailed palaeogeographical reconstruction of a southerly flowing braided to meandering stream system across an extensive alluvial flat. The lowermost three formations and particularly the Mill Bay Formation contain soft-sediment deformation structures, including small-scale ball and pillow structures, convolute lamination, loaded ripples and, most spectacularly, large scale foundering in thick beds with pillow-like clasts, reflecting seismic activity associated with the rifting of the basin.

South of the Ritec Fault, the Freshwater West Formation is overlain, possibly unconformably, by the Ridgeway Conglomerate Formation, which comprises coarse, polymict conglomerate, fine- to coarse-grained sandstone, and siltstone with calcretes. Thickness estimates range up to 465 m. The matrix-supported conglomerates are generally massive, but poor planar or cross-bedding and some clast imbrication is discernible in places. The clasts in the conglomerates are subangular to well rounded and mainly of quartzite, lithic greywacke, siltstone and vein quartz, with a marked influx of phyllite clasts in the higher beds. The formation is interpreted as having been deposited in a braided stream or alluvial fan complex, the cross-bedding, clast imbrication and clast size indicating a nearby source of Precambrian and Lower Palaeozoic rocks to the south. Some clasts have yielded fossils of possible Cambrian–Ordovician age. A northward-prograding alluvial fan occupied the area of Freshwater West, with more distal braided stream environments at West Angle Bay. *Beaconites antarcticus* occurs in the siltstones and the alga *Prototaxites* is abundant in intraformational conglomerates; both are thought to have inhabited areas in or close to active river channels. Three-dimensional bedforms and large-scale cross-bedding in some of the siltstones have been interpreted as bedload-transported pedogenic mud aggregates. The formation has yielded only non-diagnostic fossils (some crossopterygian fish fragments and plant fragments have been found), and the age is uncertain. It

has been placed variously in the late Lockovian or (if the base is interpreted as an unconformity) as Pragian to Mid Devonian.

To the east, Pragian–Emsian strata are exposed in the scarp of the Carmarthenshire Fans, the Brecon Beacons and the Black Mountains in Monmouthshire. Throughout this outcrop, the alternation of flaggy mudstone and siltstone with fine- to coarse-grained sandstone is persistent. In the lower part of the sequence, the Senni Formation, about 150 to 200 m thick, comprises green or grey-green sandstone with red-brown siltstone and mudstone interbeds. The sandstone beds range from very fine- to medium-grained, with coarser, pebbly varieties appearing at higher levels. They consist mainly of tabular sheets of lenticular, cross-bedded, channel sandstones with internal erosion surfaces. Calcrete clasts occur in the bases of sandstone bodies, along with other intraformational mudstone and siltstone debris. The sand-bodies generally fine upwards, and their tops are commonly truncated by scour or erosion surfaces. The argillaceous interbeds contain calcrete nodules, and there are also more mature, platy, massive and rubbly calcretes. Desiccation cracks are seen locally. The formation is interpreted as the product of low-sinuosity, seasonally flowing, sandy, braided streams in a mid-fan setting, the finer lithologies being floodplain lake, crevasse splay and channel abandonment facies.

The Senni Formation is characterised by the green colour of its sandstone, which is due to the presence of chloritised micas. It is particularly known for its early vascular plant remains, which include *Gosslingia breconensis*, *Hostinella heardii*, *Krithodeophyton croftii*, *Sennicaulis hippocrepiformis*, *Tarella trowenii*, *Uskiella spargens* and *Zosterophyllum llanoveranum*. High water table conditions, perhaps due to a wetter climate, are invoked for the preservation of the plant remains and the predominantly green colour of the formation. Only three fossil fish localities have been recorded. The Breconian index fossil *Rhinopteraspis dunensis* (= *R. cornubica*) is known from Primrose Hill Quarry, Crickhowell (north-west of Abergavenny), *Althaspis senniensis* from Heol Senni Quarry, south-west of Brecon, Powys, and *Pteraspis dixoni* and *Cephalaspis* sp. from Pengau (Pen-y-gau) Farm near Ferryside on the Tywi estuary. *R. dunensis* occurs in the Mid Siegenian of mainland Europe.

The Brownstones Formation is the highest Lower Old Red Sandstone formation, and comprises a sequence of fining-upward, conglomerate-sandstone-mudstone cycles in which calcretes are poorly developed. It is characterised by red-brown, fine- to coarse-grained fluvial sandstones, with red-brown, locally green, mudstone and siltstone interbeds. The proportion of mudstone decreases upwards, the succession tending to become more sandstone-dominated in its upper parts. The formation is thickest in the Forest of Dean, where 1200 m are present. In its type area, the Brecon Beacons and Black Mountains, the formation is up to about 400 m thick. From there, it thins westwards along the north crop of the South Wales coalfield, by unconformable overstep of the Upper Old Red Sandstone and then the Carboniferous. Eastwards, it thins below the Upper Old Red Sandstone on to the Usk palaeohigh, with 130 m present on the east crop of the coalfield. It also thins southwards, with about 120 m present in Gower. Angular discordance at the pre-Upper Old Red Sandstone unconformity is seen locally, for example on Bannau Brecheiniog in the Carmarthenshire Fans, from Fan Hir to Fan Foel on the Black Mountain, and on the Sugar Loaf near Abergavenny.

In the type area, the sandstones generally form extensive sheets, as seen in the north-facing scarps of the Brecon Beacons (P662422). The tabular sandbodies are parallel laminated and trough and planar cross-bedded, and consist of multistorey units of stacked, cross-cutting, channelised bodies. Sandstones also occur as single-bed, nonchannelised sheets and as thin interbeds within the mudstones. The sandstones are red-brown, purple-brown and pinkish, calcareous and micaceous, and range from fine to coarse grained. Mudstone, siltstone and calcrete clasts are common at the bases of the sandstone units, which generally fine upwards, and intraformational calcrete clast

conglomerates occupy minor channels locally. The succession is interpreted as the product of a prograding fan system that formed in a semi-arid, seasonally wet climate. The channellised sandstones are the products of mid-fan, wet season, flashy deposition, with more distal floodplain environments represented by sheet flood sandstones and mudstones and siltstones. The fine lithologies have been interpreted traditionally as floodplain mud and silt deposited from suspension in lakes or slow-moving water bodies, but some may be aeolian. Dessication cracks and rain prints on many bedding planes indicate frequent subaerial exposure.

Gravelly, pebbly and conglomeratic sandstones are locally common, particularly in the upper part of the formation in the Forest of Dean and parts of the north and east crops of the South Wales Coalfield. Pebbly beds at Llyn y Fan Fawr, 4 km west of the Swansea valley, were sourced from the east and are perhaps attributable to uplift on the Swansea valley Fault. Similarly, pebbly beds in the Cennen valley between Llandybie and Kidwelly may have been deposited as a result of uplift on the Carreg Cennen–Llandyfaelog Fault. The lithologies of the pebbles at Llyn y Fan Fawr include acid volcanics, lithic arenites and vein quartz, which may have come from locally exposed Precambrian and Cambrian outcrops. Locally derived Ludlow pebbles have been recorded at Caeras in the Cennen valley. Pebble suites at Ross-on-Wye comprise a range of igneous, metamorphic and sedimentary rocks of Lower Palaeozoic age, thought to have been derived from north Wales.

The Brownstones Formation in Wales has yielded only plant and rootlet fragments and trace fossils. However, the Dittonian index fossil fish *Althaspis leachi* has been recorded from the Wilderness Quarry in the Forest of Dean.

Near Cardiff and Newport in south-east Wales, the St Maughans Formation is overlain by the Llanishen Conglomerate Formation, about 150 m thick and consisting of interbedded purplish red conglomerate, sandstone, siltstone, mudstone and calcrete. The Llanishen Conglomerate is exposed in the Cowbridge and Rogerstone anticlines, and its excavation during the construction of the M4 Motorway yielded much new information. The lithologies are organised in upwards-fining cycles and erosion surfaces are common, especially in the coarser beds; calcrete profiles occur in the finer beds. The sequence is a proximal alluvial facies, the conglomerates and sandstones being the deposits of stream channels that interdigitated, both laterally and downslope, with siltstones and mudstones that accumulated across mudflats. In places, a calcareous cement is leached out at the surface to produce an unconsolidated gravel. The clasts in the conglomerate consist of possible Silurian volcanic or pyroclastic rocks (about 50 per cent), lithic sandstones and pink (Llandovery?) quartzite. The pebbles and cobbles are lilac to purple, subrounded to subangular, and many have dark purple, surficial iron-staining. The lithologies are closely comparable with those of the Ridgeway Conglomerate Formation, in south Pembrokeshire. Internal bedforms and the suite of pebbles in the conglomerate, which are unlike the northerly derived pebbles found in most of the Old Red Sandstone succession, suggest that the Llanishen Conglomerate, like the Ridgeway Conglomerate, was derived from the south.

Throughout south Wales, the generally coarsening-upwards sequence in the Lower Devonian reflects an increasingly proximal alluvial facies that was probably initiated by uplift, to the north. The southwards progradation of the facies belts and migration of the fluvial fall-line at the deformation front resulted in erosion and nondeposition throughout the mid Devonian in most of Wales when the alluvial systems deposited sediment in the sea to the south. The top of the Lower Old Red Sandstone is marked by a profound unconformity.

Bibliography

ALLEN, J R L. 1974. The Devonian rocks of Wales and the Welsh Borderland. 47–84 in *The Upper*

Palaeozoic and post-Palaeozoic rocks of Wales. OWEN, T R (editor). (Cardiff: University of Wales Press.)

ALLEN, J R L, THOMAS, R L, and WILLIAMS, B P J. 1982. The Old Red Sandstone north of Milford Haven. 123–149 in *Geological excursions in Dyfed, south-west Wales*. BASSETT, M G (editor). (Cardiff: Published for the Geologists' Association by the National Museum of Wales.)

BARCLAY, W J, MCMILLAN, A A, PICKETT, E A, STONE, P, and WILBY, P R. 2005. The Old Red Sandstone of Great Britain. *Geological Conservation Review Series,* No. 31.

DAVIES, J R, MCNESTRY, A, and WATERS, R A. 1991. Palaeoenvironments and palynofacies of a pulsed transgression: the late Devonian and early Dinantian (Lower Carboniferous) rocks of southeast Wales. *Geological Magazine*, Vol. 128 (4), 355–380.

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