Wales - an introduction

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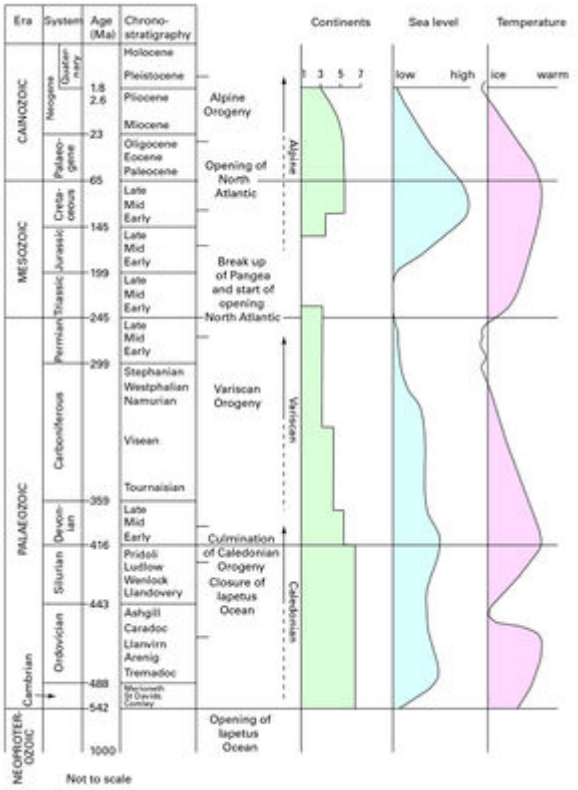
From: Howells, M F. 2007. British regional geology: Wales. Keyworth, Nottingham: British Geological Survey.

Maps:

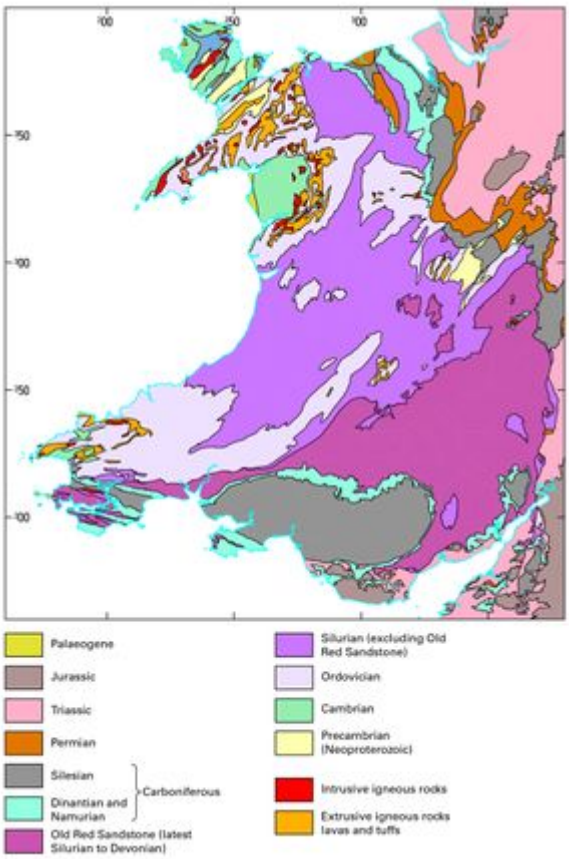
1:250,000 map of Wales

Other maps including the 1:50,000 maps covering Wales

Geology of Britain viewer



Timescale of major geological events in Wales. P916216.



Geology of Wales. P916142.

Topography of Wales and adjacent area. P916143.

Snowdon massif viewed from the east, at Curig Hill across Llynnau Mymbyr to the Snowdon Horseshoe, Llewedd, Yr Wyddfa, Crib y Ddysgl and Crib Goch. (MFH P662385).

North Pembrokeshire coast viewed westwards from Carn Llidi, across Whitesands Bay to Ramsey Island (C D R Evans P662386).

Great Ormes Head, Llandudno. The Loggerheads Limestone Formation is exposed in the main cliff face with a capping of the Cefn Mawr Limestone and Red Wharf Limestone formations (MFH P662387).

This book describes the geology of Wales that is shown on the 1:625 000 scale geological map of the Principality of Wales and replaces earlier editions of this series in which north and south Wales were described in separate volumes. Unlike the earlier editions, some of the most pertinent data,

retrieved in recent years, from the offshore areas, Liverpool Bay, Caernarfon Bay, Cardigan Bay and the Bristol Channel, have been included. These data serve to complete the geological history and context of Wales and especially so in reference to plate tectonic models.

Within Wales and the adjacent sea, elements of all the major geological systems are to be found (P916216), and for much of the country the differences in the geology (P916142) and map in back pocket) are reflected in the topography (P916143) and the scenery. The main exception is the low-lying coastal area of south Wales, between south Glamorgan and Pembrokeshire, which is underlain by folded Palaeozoic rocks but lacks the topographical features of similar strata at higher elevations inland. The contrast reflects a difference in the erosional history, with the coastal areas having been submerged and repeatedly eroded by the sea in more recent geological times.

In Anglesey and Llŷn, there is the largest outcrop of Precambrian rocks in southern Britain, and smaller outcrops occur in Pembrokeshire, Carmarthenshire and Radnorshire. However, Wales is dominated by Lower Palaeozoic rocks — the Cambrian and Ordovician in Llŷn, Snowdonia National Park and north Pembrokeshire and the Silurian over much of central Wales. The sequence is mainly of marine sedimentary rocks, and the recognition of distinctive facies and thickness changes across the outcrops has allowed detailed reconstruction of a marine basin and its shorelines throughout this time. Within the Cambrian, the sedimentary rocks range from silty mudstone, such as those displayed in the great quarries between Nantlle and Bethesda in the north Wales slate belt, and coarse-grained sandstone, as exposed in the castellated ridges of the Rhinog Mountains. The basin in which the sediments accumulated was initiated by major fractures in the Precambrian basement and its evolution was controlled by periodic tectonic activity along these fractures, causing both uplift and subsidence. During Ordovician times, volcanic activity was a major feature and the thick accumulations of widely variable volcanic rocks profoundly modified the sedimentary environments. The spectacular scenery throughout the Snowdonia National Park is due largely to the volcanic rocks and their resistance to weathering (P662385). Similarly, in Pembrokeshire, the indented coastline around the northern headland of St Bride's Bay (P662386) reflects the differing resistance to erosion of the volcanic rocks and the interbedded, less competent sedimentary rocks. In late Ordovician and Silurian times, when major volcanic activity had ceased, sedimentation was dominated by fine silt and mud which, when lithified, uplifted and eroded, produced the characteristically smooth profiles of the hills through much of central Wales and the Denbigh moors (Mynydd Hiraethog).

During late Silurian and early Devonian times, the Lower Palaeozoic basin contracted and the rocks were folded and uplifted in the final phase (Acadian) of the Caledonian orogeny to form part of a continental surface that extended from the position of the Bristol Channel into northern Britain; at this time the sea lay to the south. The major folds of this orogeny in Wales, such as the Harlech and Berwyn 'domes' and the intervening Central Wales Syncline, can be discerned in the current topography. Similarly, the line of the Bala Fault Zone and its branch along Tal y Llyn and the Dysynni valley is well featured. The emergent land was the site of fluvial, alluvial and lacustrine sedimentation, which produced the Old Red Sandstone continental facies in late Silurian and Devonian times. These Old Red Sandstone rocks are well exposed from Pembrokeshire in the west, through the scarp feature of the Black Mountains and Brecon Beacons, to Herefordshire in the east, and for much of this outcrop they lie with marked discordance on the eroded surface of the folded Lower Palaeozoic sequence. The rich agricultural terrain in the lower ground of the Old Red Sandstone outcrops contrasts sharply with the relatively impoverished ground at similar altitudes in the Lower Palaeozoic outcrops. The absence of Middle Devonian rocks across Wales reflects uplift, possibly the final expression of the Caledonian orogeny. As a result, the Upper Old Red Sandstone sequence is incomplete and everywhere rests unconformably on older strata. The appearance of marine fossils towards the top of this sequence indicates the initiation of a marine transgression,

from the south, which reached its full expression in early Carboniferous times.

The Carboniferous rocks accumulated in shallow basins marginal to a remnant of the landmass, formerly known as St George's Land but now generally referred to as the Wales–Brabant Massif. This landmass occupied most of the area of central and north Wales. In early Carboniferous times, the influx of coarse detritus from this low-relief landmass was minimal, and conditions were ideal for the precipitation of carbonate to form the extensive limestones that are a dominant feature of the scenery in south Pembrokeshire and Gower in south Wales and on Anglesey, at Great Orme (P662387) and on Mynydd Eglwysseg, near Llangollen in north Wales. In addition, they form an almost continuous and well-defined outcrop around the major east–west-orientated syncline of the South Wales Coalfield and, in the north, they overstep on to the Lower Palaeozoic strata on the east side of the Clwydian Hills and in the Vale of Clwyd.

In later Carboniferous times, uplift caused temporary emergence of the depositional surface and much coarse clastic debris was deposited in a complex of brackish deltas that were periodically flooded by marine incursions. Tropical rain forest developed along the low lying coastline; the accumulations of vegetation in swamp conditions developed into layers of peat, which eventually lithified into the coal seams of the Upper Carboniferous. The numerous coal seams are the result of the constant repetition of these processes, which were accommodated by subsidence being related to continued tectonic activity. It is the exploitation of the coal, clay and ironstone within this part of the stratigraphical column that has profoundly modified the scenery of the south Wales valleys over the last two centuries.

The earth movements or tectonism that affected the sedimentation patterns in early Carboniferous times reached its climax in the Variscan orogeny, in the late Carboniferous, when the sequence was folded and uplifted to form part of a mountain chain, the Variscides, which extended eastwards from southern Ireland into north-west Europe. In south Wales, where the affects of this period of deformation are most clearly recognised, an east–westtrending syncline from Pembrokeshire to Monmouthshire forms a major topographical feature, but the most intense folding and faulting is displayed in the coastal sections in Pembrokeshire and south Gower.

Following the Variscan orogeny, a new cycle of erosion and sedimentation was initiated and a different fauna and flora, characteristic of the Mesozoic era, was established. The red sandstones and siltstones of the Permian and Trias comprise material derived mainly from the erosion of the Carboniferous rocks and redeposited in a semi-arid environment. The sequence crops out in the Vale of Glamorgan, in the south, and on the western flank of the Cheshire Basin and the Vale of Clwyd, in the north. Progressively, the Triassic landmass was submerged and, in early Jurassic times, the grey marine mudstone and thin limestones that are so graphically displayed in the cliff sections in south Glamorgan were deposited. Extensive and thick sequences of these Mesozoic rocks also occur in the immediate offshore areas. Whether the later Cretaceous (Chalk) sea completely submerged Palaeozoic Wales is a matter of some contention.

Towards the end of Mesozoic times, the repercussions of the Alpine orogeny in southern Europe constituted the main influence on the configuration of land and sea. Most of the area was uplifted, although throughout much of Cainozoic times a marine basin persisted along the Irish Sea. Offshore hydrocarbon exploration has revealed thick sequences of both Cainozoic and Quaternary strata that were derived entirely from the adjacent land. Onshore, evidence of the Pleistocene glaciation is almost entirely of the last glacial episode when local ice covered most of Wales; the most graphic evidence is displayed in erosional features in the upland areas, both valleys and ridges, and particularly in Snowdonia. At the same time a major ice sheet occupied the Irish Sea, and its southward movement was deflected by the north edge of the Welsh landmass forcing it across Anglesey and Llŷn in the west and into Cheshire and Shropshire in the east.

At the beginning of Holocene times the climate showed marked signs of improvement and, in a short time, a deciduous forest was established over most of Wales. Sea level changes continued subsequent to the melting of the ice sheets and it was not until some 5000 years ago that current sea level was attained. However, the submerged forests which are such a feature around the coast of Wales, together with the extensive tracts of river and estuarine alluvium, indicate the continued changes in the relative positions of land and sea.

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