Hydrogeology of Wales: Summary

This page is part of a category of pages that provides an updated review of the occurrence of groundwater throughout Wales.

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Wales enjoys a humid westerly airstream which provides a plentiful source of water. Public supply largely depends on upland gathering and surface storage, but groundwater is also supplied. Approximately 250 Ml d^{-1} (91 Mm^3 a^{-1}) or about 8 per cent of the total water in public supply in Wales derives from groundwater and a further 95 Ml d^{-1} (34 Mm^3 a^{-1}) is abstracted for private consumption from about 21 000 boreholes, wells and springs. Private abstraction is limited and of a local scale because of the indurated and fractured nature and modest permeability of many of the aquifers. It is nevertheless of significant social and economic importance and is used for drinking water, farming, and light industry. Development of groundwater remains patchy due to a perception that it is unlikely to be present in useable quantities in areas such as the hard rock terrains typical, for example, of much of central and west Wales. Groundwater is also important as it maintains low river flows during dryer periods.

The traditional perception of groundwater in Wales is as an insignificant resource that has been a hazard to the mining communities. The Water Framework Directive (**European Community, 2000)** has brought new impetus to the understanding of groundwater in Wales as the Directive requires that the physical and chemical status of even the smallest producing aquifers be reviewed and remedial targets set. There are also several significant innovative groundwater schemes in Wales, including the Clwyd Augmentation/Abstraction Scheme and hydrogeological investigations carried out during the development of the Cardiff Bay Barrage.

Wales has a wide range of aquifers that reflect its diverse geology. These include the Triassic sandstone aquifer in the Vale of Clwyd in north Wales, the only aquifer designated as Principal A type by the Environment Agency Wales, the ‘Old Red Sandstone’ of the Brecon area and large areas of Carboniferous Limestone. Quaternary and alluvial deposits also provide some resource potential.

Much of central and upland Wales comprises Lower Palaeozoic and older bedrock. There are large areas of metasedimentary strata, typified by rocks such as mudstone, siltstone and sandstone which offer shallow fracture porosity and storage with no supporting intergranular storage. The Silurian and Ordovician rocks of west Wales, for example, sustain small springs and shallow boreholes enough to supply rural demand. The alluvial deposits that floor most valleys provide additional storage if they are in hydraulic continuity with the fractured bedrock. Deeper circulation occurs in the Llandrindod Wells area of central Wales where a number of chemically mature spring sources were used as Victorians spa resorts.

Devonian sandstones and mudstones crop out to the north and east of the South Wales Coalfield. Shallow weathering and fracturing provide storage and transport to groundwater although there is little intergranular storage. Nevertheless the aquifer is widely exploited from modest yielding springs and boreholes for rural and agricultural supply. The average transmissivity is 51 m^2 d^{-1}.

Carboniferous Limestone covers extensive areas in both north and south Wales. Groundwater flows through the Carboniferous Limestone via fractures and available karst features. Swallow holes are common in the main Carboniferous Limestone outcrops.

The Millstone Grit Facies is poorly represented at outcrop in Wales but the overlying Coal Measures are widespread in both the North Wales and South Wales coalfields. In north Wales groundwater transport and storage are limited to available fractures although there is some storage available in the sandstone horizons and in former mine voids. The working collieries all required to be dewatered, with shaft sump discharges generally of between 5 and 20 l s^{-1}, although some pumping rates fluctuated seasonally. Groundwater may be locally confined by till, and yields up to 5 l s^{-1} have been attained in boreholes, exceptionally 15 l s^{-1} at a borehole near Mold. However, both vertical and horizontal conductivity are poor and initial pumping rates may not always be sustainable.

In south Wales the Coal Measures comprise low permeability hydrogeological units composed of carbonaceous mudstones and sandstones with subordinate siltstones and coal seams. The Pennant Sandstone Formation is dominated by sandstone while the Lower and Middle Coal Measure formations are dominated by mudstone. Moreover the Pennant sandstones are generally thick, massive, feldspathic and micaceous and form the relatively high ground at the centre of the South Wales Coalfield. The permeabilities of the sand horizons are generally less than 1 m d^{-1}. Fracture permeability enhances the transmissive properties of these rocks although secondary deposition of silica may inhibit matrix permeability. Folding and faulting has produced some secondary fracture permeability, and mining activity tends to enhance fracture permeability in the overburden. At outcrop, borehole yields up to 8 l s^{-1} are feasible, but the permeability of the sandstone horizons depends on the distribution and intensity of fractures within them.

The Triassic sandstone aquifer in the Vale of Clwyd is situated in a small graben some 5 km wide. The sandstone is concealed by up to 80 m of glacial till, and some fluvioglacial gravel material. The main aquifer is in the Ruthin and Denbigh area in which the central part of the aquifer was originally confined by till with an artesian head of about 6 m. Transmissivity is between 800 and 2000 m^2 d^{-1} and storativity between 10^{-3} and 10^{-4}.

Quaternary deposits include a variety of tills, both according to their depositional history and their lithology, and a complex array of fluvioglacial sands and gravels. There are also Recent alluvial and lacustrine deposits. The granular superficial deposits form shallow aquifers in low-lying areas such as valley bottoms. There are several important groundwater-dependent ecosystems including coastal dune-lands and significant domed peats, such as Tregaron in the upper Teifi catchment in west Wales.

Groundwater has stable physical and chemical properties, which are beneficial to a number of key industries. It provides a source of alkalinity when discharged as base flow to often acidic surface waters and the base flow maintains low river flows during dryer periods. Groundwater can also be a potential hazard and was of great concern to the metal and coal mining industries in their heyday. Coal production in south Wales peaked in 1926, the year of the General Strike, but declined steadily thereafter, the last working pit closing in 2008.

High rainfall and recharge coupled with low transmissivities, promote shallow water tables in many areas with a consequent complex relationship between surface water and groundwater. Contamination of groundwater by acid mine drainage in parts of south, west and north-east Wales, coupled with risks from contaminated land, the latter a legacy of the heavy industry that used to be prevalent in the valleys of south and north-eastern Wales, may have an adverse impact on groundwater (and surface water) quality. Diffuse pollution from agriculture and forestry is also a problem in some areas. Nevertheless, the resource is underexploited and considerable potential exists for abstraction of good-quality groundwater in much of Wales.

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