



The Mineral Resource Maps of Wales

Minerals and Waste

Mineral Resources and Policy Team

Geology and Landscape Wales

Open Report OR/10/032



BRITISH GEOLOGICAL SURVEY

MINERALS AND WASTE

MINERAL RESOURCES AND POLICY TEAM

GEOLOGY AND LANDSCAPE WALES

The Mineral Resource Maps of Wales

A.J. Humpage and T.P. Bide

The National Grid and other Ordnance Survey data are used with the permission of the Controller of Her Majesty's Stationery Office. Ordnance Survey licence number Licence No:100037272/2010.

Keywords

Wales; Minerals, Resources, Resource Maps

Front cover

Taff's Wells quarry, working Carboniferous limestone, Ffos y Fran surface mine working the Coal Measures and Barnhill quarry working Pennant sandstone. BGS © NERC

Bibliographical reference

HUMPAGE, A.J. and BIDE, T.P. 2010. The Mineral Resource Maps of Wales *British Geological Survey Open Report*, OR/10/032. 49pp.

Copyright in materials derived from the British Geological Survey's work is owned by the Natural Environment Research Council (NERC) and/or the authority that commissioned the work. You may not copy or adapt this publication without first obtaining permission.

Contact the BGS Intellectual Property Rights Section, British Geological Survey, Keyworth, e-mail ipr@bgs.ac.uk You may quote extracts of a reasonable length without prior permission, provided a full acknowledgement is given of the source of the extract.

© NERC 2010. All rights reserved

Keyworth, Nottingham British Geological Survey 2010

BRITISH GEOLOGICAL SURVEY

The full range of Survey publications is available from the BGS Sales Desks at Nottingham, Edinburgh and London; see contact details below or shop online at www.geologyshop.com

The London Information Office also maintains a reference collection of BGS publications including maps for consultation.

The Survey publishes an annual catalogue of its maps and other publications; this catalogue is available from any of the BGS Sales Desks.

The British Geological Survey carries out the geological survey of Great Britain and Northern Ireland (the latter as an agency service for the government of Northern Ireland), and of the surrounding continental shelf, as well as its basic research projects. It also undertakes programmes of British technical aid in geology in developing countries as arranged by the Department for International Development and other agencies.

The British Geological Survey is a component body of the Natural Environment Research Council.

British Geological Survey offices

Columbus House, Village Way, Greenmeadow Springs, Tongwynlais, Cardiff, CF15 7NE

☎ 029-2052 1962 Fax 029-2052 1963
e-mail: bgs-wales@bgs.ac.uk

Keyworth, Nottingham NG12 5GG

☎ 0115-936 3241 Fax 0115-936 3488
e-mail: sales@bgs.ac.uk
www.bgs.ac.uk
Shop online at: www.geologyshop.com

Murchison House, West Mains Road, Edinburgh EH9 3LA

☎ 0131-667 1000 Fax 0131-668 2683
e-mail: scotsales@bgs.ac.uk

London Information Office at the Natural History Museum (Earth Galleries), Exhibition Road, South Kensington, London SW7 2DE

☎ 020-7589 4090 Fax 020-7584 8270
☎ 020-7942 5344/45 email: bgs-london@bgs.ac.uk

Geological Survey of Northern Ireland, Colby House, Stranmillis Court, Belfast, BT9 5BF

☎ 028-9038 8462 Fax 028-9038 8461

Maclean Building, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB

☎ 01491-838800 Fax 01491-692345

Parent Body

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon, Wiltshire SN2 1EU

☎ 01793-411500 Fax 01793-411501
www.nerc.ac.uk

Foreword

This is a short descriptive summary to accompany the six maps which have been published as part of the Mineral Maps of Wales project, co-funded by the Welsh Assembly Government administered Aggregates Levy Sustainability Fund for Wales and the British Geological Survey Mineral Resources and Policy Team. A final publication, “A Guide to Mineral Resource Information and Aggregates Safeguarding in Wales” will be published on completion of the project due in late 2010.

Knowledge about mineral resources is essential for making effective and sustainable planning decisions. The Mineral Resource Maps of Wales address mineral resource issues relating to land-use planning and by providing access to the relevant information, will improve the effectiveness of planning and decision-making on minerals issues and will enable better quality engagement, consultation and debate.

The Minerals Maps of Wales Project has been overseen by a Steering Group consisting of members from the Welsh Assembly Government, Mineral Planning Authorities, industry and environmental agencies.

Contents

Foreword	i
Introduction	1
What is a Mineral Resource?	2
<i>Sand and Gravel</i>	3
<i>Peat</i>	3
<i>Igneous Rocks</i>	4
<i>Sandstone</i>	4
<i>Limestone</i>	5
<i>Slate</i>	5
<i>Brick Clay</i>	6
<i>Fireclay</i>	6
<i>Coal</i>	6
<i>Salt</i>	7
<i>Metallic Minerals</i>	7
<i>Building Stones</i>	8
The Mineral Resource Maps of Wales	9
Regional Mineral Resources Overview	10
<i>South-east Wales</i>	10
<i>South-west Wales</i>	11
<i>Mid Wales (South)</i>	12
<i>Mid Wales (North)</i>	12
<i>North-west Wales</i>	13
<i>North-east Wales</i>	13
Further Reading	15

Introduction

Minerals are essential for the development of a modern economy, but mineral resources are finite and they can only be worked where they occur. As their extraction is subject to a number of constraints, it is essential that society uses minerals in the most efficient and sustainable manner. Identifying the distribution of known mineral resources in Wales and presenting them in a consistent fashion across the whole country allows minerals to be considered with other land-use information and permits more effective and sustainable management strategies to be developed.

The British Geological Survey has undertaken a commission through its Mineral Resources and Policy team, led from the BGS Cardiff office, to prepare for the Welsh Assembly Government a series of six mineral resources maps which cover the whole of the Principality of Wales. This work was completed in June 2010 and the series of digitally generated maps at a scale of 1:100 000 are now available. These maps cover the 25 Unitary and Mineral Planning Authority areas of Wales.

Wales contains a wide range of minerals, many of which have been exploited since historical times. There are still significant energy resources in the coalfields of South and North-east Wales, limestones and sandstones across Wales with a range of aggregate and industrial uses and significant deposits of sand, gravel and clay. These resources are important national assets and adequate and steady supplies are needed to maintain current and future economic development.

The major elements of minerals information presented on the maps are:

- The geological distribution of all onshore (above low water mark) mineral resources in Wales

- The location of mineral extraction sites

- The recorded occurrences of metallic minerals

- The recorded location of former slate quarries and significant areas of slate waste

- The recorded location of historic building stone quarries

What is a Mineral Resource?

A mineral resource is a concentration or occurrence of material of intrinsic economic interest in or on the Earth's crust in such form, quality and quantity that there are reasonable prospects for eventual economic extraction.

Generally, a mineral resource is known to exist within the boundaries outlined by geological mapping. This may be supplemented by more detailed geological data. The Mineral Resource Maps of Wales developed by the British Geological Survey (BGS) show the surface extent of mineral resources (Figure 1). These are mostly inferred from available geological information and they generally have not been evaluated by drilling or by other sampling methods on any systematic basis. The mineral resources defined on the maps show the areas within which potentially workable minerals may occur. What may be of economic interest can change over time, and is dependent upon a number of factors, such as mineral markets and extraction technology.

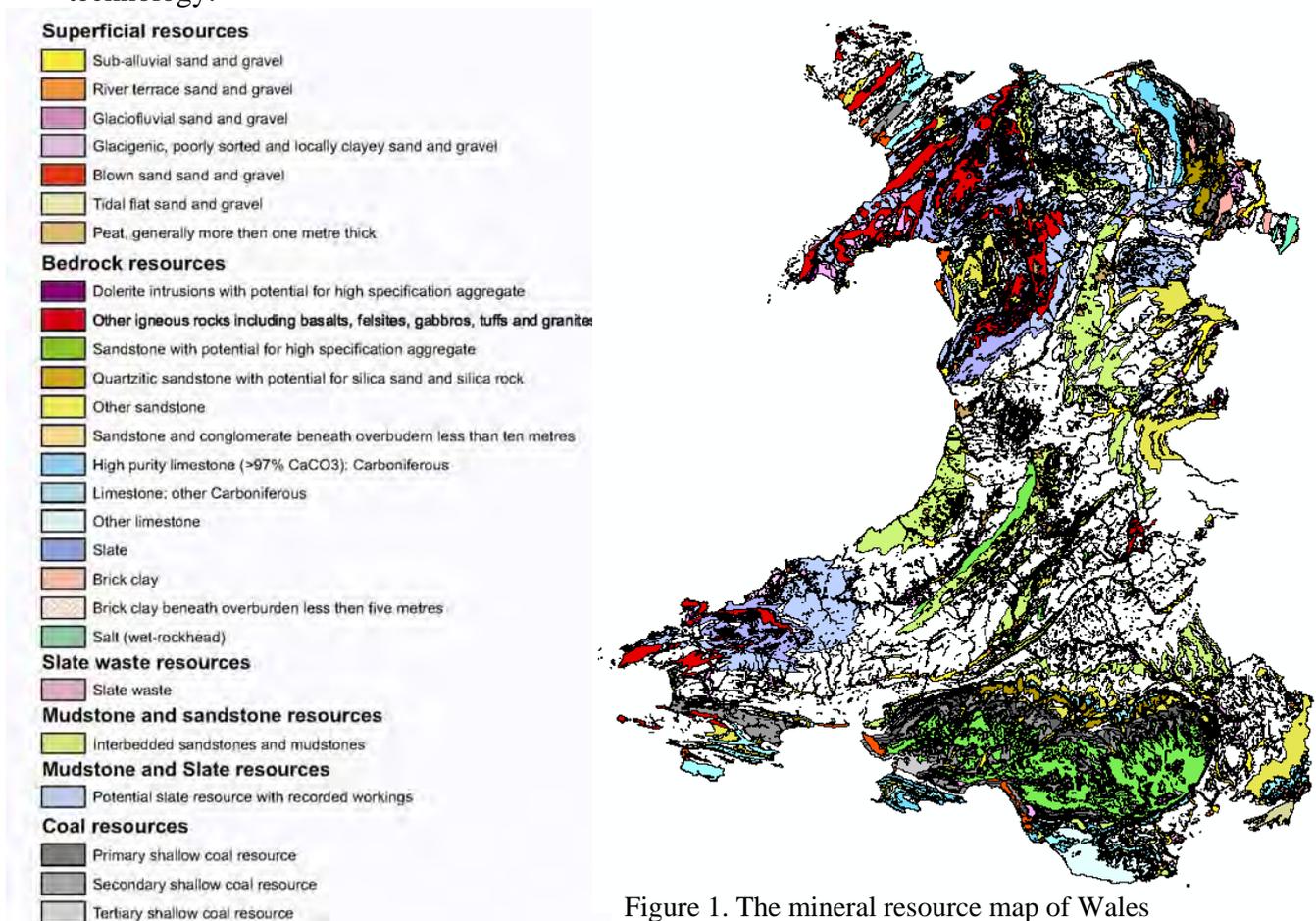


Figure 1. The mineral resource map of Wales

The Mineral Resource Maps thus show all minerals which geologically have resource potential in Wales, irrespective of extent of the deposit and proximity to markets or other economic factors.

Mineral Resources of Wales

The Mineral Resources of Wales can be divided into those which are obtained from unconsolidated superficial deposits (formerly termed the “drift”) such as sand and gravel, and those derived from “solid” bedrock sources such as sandstone and limestone.

Sand and Gravel

Sand and Gravel deposits are accumulations of more durable rock fragments and mineral grains which have been derived from the weathering and erosion of hard rocks mainly by glacial and fluvial actions, but also by wind erosion. The properties of gravel, and to a lesser extent sand, largely depend on the properties of the original bedrock from which they were derived. However, water action is an effective mechanism for wearing away weaker particles, as well as separating different size fractions. Most sand and gravel is composed of particles that are durable and rich in silica (quartz, quartzite and flint).

Sand and gravel has a variety of construction applications, such as for concreting aggregate, and can be classified into two categories depending on age and geology, namely (i) superficial deposits and (ii) bedrock.

Superficial Deposits comprise all those sediments laid down during the last 2.6 Million years. In Wales, onshore sand and gravel deposits derived from superficial deposits lie on top of the bedrock geology and are generally concentrated in the river valleys where they were deposited directly by ice at the margins of glaciers (glacigenic) or by meltwater flowing from the ice margin (glaciofluvial). Sand and gravel resources may also be found in river terraces and below the river flood plain surface (sub-alluvial). In the coastal areas of Wales, blown sand deposits form extensive dune fields above high water whilst below high-water mark, some tidal flat deposits are dominated by sand grade sediments.

Bedrock deposits of sand and/or gravel are possible sources of supply in the Vale of Clwyd, where relatively unconsolidated Triassic age bedrock sandstone resources have the potential to be easily worked and crushed to provide sand and gravel. Much of this resource is buried beneath significant thicknesses of younger non-resource superficial deposits, but where overburden is less than ten metres thick, exploitation is feasible.

Peat

Peat is an unconsolidated deposit formed by decaying organic matter which accumulates in a water-saturated environment such as a bog or moss. Bogs occur in areas where they are dependent on rainfall for supply of water or in sedimentary basins such as former lakes. Vegetation is characterised by acid tolerant plant communities of which the genus *Sphagnum*

is dominant. The two main types of bog are (i) raised bogs, characteristic of flat underlying topography and found on plains and broad valley floors and (ii) blanket bogs, which occur mainly in upland areas where conditions are suitably cool and wet. Peat is cut locally for fuel but its main usage is as a horticultural growing medium, although its potential as a carbon sink has been recognised. Across upland Wales are extensive areas of blanket bog, whilst in some river valleys and coastal areas, significant thicknesses of raised bog occur which may be infilling former lagoons or glacial lakes behind other coastal deposits or older glacial deposits respectively.

Igneous Rocks

Igneous rocks are derived from molten rock solidifying either deep below the earth's surface (e.g. granite) at the surface (e.g. basalt) or in water or on land after falling as ash from the atmosphere (e.g. tuff). Aggregates derived from igneous rocks have a range of constructional usages, from railway ballast and bulk aggregate to decorative stonework. Granite at Tan-y-grisiau in North Wales is worked for building stone. Dolerite, a medium grained igneous rock intruded into the shallow crust has potential high specification aggregate uses such as for road surfacing due to its high skid resistance.

Sandstone

Sandstones are sedimentary rocks consisting of sand-sized particles composed predominantly of quartz but with variable amounts of feldspar and rock fragments set in a fine-grained matrix or cement.

Sandstones of different geological ages can be found across Wales but they differ widely in their thickness and physical properties, and thus their resource potential. Generally sandstone is crushed for a range of different applications, although some units are suitable for the production of dimension stone or flagstones. In mid Wales and within the South Wales coalfield, some sandstone units are more indurated and have physical properties (e.g. grading, density, strength) which results in a high polishing and abrasion resistance, making them suitable for very high specification aggregate usages such as motorway road surfacing.

Quartzitic sandstone is very pure sandstone (up to 99% SiO₂) which can be used for aggregate, but has specialised industrial uses because of its physical and chemical properties. Primarily their properties are a narrow grain size distribution (generally in the range 0.5 to 0.1mm) and very low levels of deleterious impurities, particularly clay, iron oxides and refractory minerals, such as chromite. It was formerly exploited for use in the metal industry (abrasives) and in the production of refractory bricks for furnace lining.

Limestone

Limestone is a sedimentary rock consisting primarily of calcium carbonate (CaCO_3) although units of calcium magnesium carbonate $\text{CaMg}(\text{CO}_3)_2$ (dolomite) are also found in Wales. Limestone has a variety of uses – it can be crushed, ground or calcined (burnt to make lime) for a variety of constructional and industrial applications. As most limestones are hard and durable the rock is useful for aggregate, but it also has a variety of non-aggregate industrial uses which utilises its chemical properties.

Much of the limestone in Wales is of Carboniferous age, and this resource can be sub-divided by the identification of high purity limestone which comprise greater than 97% calcium carbonate. High purity limestone is used extensively by the industrial sector in the manufacture of paints and plastics. Other Carboniferous limestones are exploited as aggregate. In the Vale of Glamorgan, Jurassic age limestones are utilised in the manufacture of cement, whilst across mid Wales, small outcrops of Silurian age limestone and Devonian calcretes have been exploited in the past, often to produce lime for agricultural purposes.

Slate

Slate is a fine grained metamorphic rock formed by the alteration of mudstone through the combined effects of heat and pressure. This results in the formation of a well-marked slaty cleavage due to the recrystallisation and realignment of platy clay minerals along a single set of micron-spaced parallel planes, allowing it to be split into thin leaves. Slaty cleavage controls the splitting properties and thickness of slate tiles or flagstones used for roofing or other architectural purposes. Slate can also be sawn into slabs, and being hard and durable, has a large range of applications, from external roofing and cladding to internal flooring; slate can also be polished for use as work surfaces and in decorative pieces. Wales has a long history of working this material, and throughout the 19th and 20th centuries was major source of slate for use in construction. Slate is still worked in North Wales around Blaenau Ffestiniog and Corris for constructional and decorative applications. During the early 19th century, attempts were made to establish a slate industry in Pembrokeshire around the Preseli Hills with limited success and working had ended by the 1890s.

Bodies of commercial slate generally have a restricted occurrence within more extensive masses of less perfectly cleaved rock, and this other material, largely rejected during nineteenth and twentieth century quarrying, was usually tipped on the hillsides around the associated quarry resulting in large tips of slate waste. The more extensive tips, particularly in North Wales, are a potential source of constructional aggregate for a range of low and medium specification uses. A small quantity is used in the production of slate granules, used in roofing felt, and slate powder which has a number of industrial uses such as a filler in bituminous paints.

Brick Clay

Brick clay is clay and shale used in the manufacture of structural clay products such as bricks, tiles and pipes. Fireclay (see below) is also used in the manufacture of these products, particularly bricks, in some areas. Brick clays are sedimentary mudstones of different geological ages and compositions, ranging from relatively soft, plastic clays to hard mudstones. Their chemical properties, which are related to their mineralogical composition, and physical properties, particularly grain size, are critical to determining their suitability for the manufacture of structural clay products. In Wales, the principal sources of brick clay include the Carboniferous mudstones extracted in conjunction with coal seams. These clays generally have a high carbon content which aids the firing process as less additional fuel is required. In North Wales, Ruabon was a major centre for brick making, exploiting the Carboniferous age Ruabon Marl whilst in South Wales, Triassic age Mercia Mudstone around Cardiff was exploited into the 1980s.

Fireclay

Fireclays are non-marine sedimentary mudstones found in Carboniferous age strata as “seatearth” beneath coal seams and are commonly one metre thick or less, although rarely they exceed three metres in thickness. Seatearths represent fossil soils on which the coal-forming vegetation once grew and they are distinguished from other similar sediments by the presence of rootlets and the absence of bedding. Fireclays consist essentially of the clay mineral kaolinite with varying proportions of hydrous mica and quartz, together with some minor impurities such as ironstone nodules and carbonaceous matter. Typically, they are extracted in association with opencast coal, and they fire to a buff-brown colour because they contain less iron than brick clays. Fireclay products have a higher resistance to heat (hence the name) and were originally used in the manufacture of refractory furnace linings. They are now mainly used to make high quality structural clay products, such as buff and yellow facing bricks.

Coal

Coal is a combustible sedimentary rock made of lithified plant remains. It consists of “macerals” (organic equivalent of minerals), minerals and water. A coal seam (layer) is formed by the alteration of dead plant material that initially accumulates as peat on the land surface. As the peat becomes buried beneath younger sediments the temperature increases with increasing depth of burial. Peat is sequentially altered by the process of “coalification” through “brown coals, which include lignite and sub-bituminous coal, to “black coals” that comprise bituminous coal, semi-anthracite and anthracite. Coalification involves the loss of water and volatile components in the form of carbon dioxide and methane, resulting in an increase in carbon content, from about 60% in peat to more than 95% in anthracite. As a result of subsequent faulting and folding of coal-bearing strata, coal seams occur at varying depths from the surface. Coal seams vary in thickness from a few centimetres up to five

metres in exceptional cases, although this is rare. Coal can be extracted by both underground (deep) mining and surface (opencast) mining.

Bituminous and anthracite coals are found in Wales, particularly the South Wales Coalfield, where the coal “rank” become increasingly anthracitic towards the west. Within the bituminous coal zone, a distinction can be made between “steam coal”, which is used for burning in boilers, chiefly to generate electricity in coal-fired power stations and “coking coal”, which is used to make coke for the metallurgical industries and has the strength to support the loads imposed within the blast furnace. In Wales, coal is mainly extracted by surface mining from Carboniferous age sedimentary rocks, although some small drift mines are active in the South Wales coalfield.

Salt

Salt (sodium chloride) is formed by the evaporation of shallow water bodies and occurs in nature in solid form as rock salt (halite), or in solution as brine. Rock salt is a soft sedimentary rock occurring in beds, commonly associated with mudstone, ranging from a few centimetres up to several hundred metres in thickness. The purity of individual salt beds depends on the extent of mudstone interbedding. The western margins of the Cheshire salt basin impinge on Flintshire although salt-bearing strata do not crop out at the surface because of dissolution by groundwater. Salt extraction is not currently occurring in Wales. Salt has extensive uses, including for chemical and industrial applications such as the production of caustic soda and chlorine and as road salt for winter driving, as well as for household consumption.

Metallic Minerals

The extraction of metallic minerals in Wales predates the arrival of the Romans, and extraction continued economically until the 1930s, although the industry reached its zenith in the early- to mid-nineteenth century. Most metallic minerals in Wales occur in veins with the greatest concentrations in the main ore bearing rocks of mid and north Wales, although isolated occurrences are recorded across the country outside these areas. The mineral veins occur as linear, sub-vertical deposits infilling faults and fissures that cut rocks of various geological ages. The industry gradually declined in the face of the high cost of working this style of mineralisation and competition from lower cost producers overseas. Lead and silver were produced in mid Wales from a series of mines inland from Aberystwyth. Copper was mined in Snowdonia and at Parys Mountain on Anglesey whilst gold was exploited around Dolgellau and Pumsaint. A number of other metals were produced including zinc, arsenic, antimony and manganese.

Building Stones

Building stone describes any rocks used for masonry, walls, pavements and roofing material in the construction of buildings and other structures, such as bridges and monuments. Stone has been used for building and roofing purposes in the UK for over two thousand years and the geological diversity of the country has meant that the variety of the rock types used is probably unmatched anywhere else in the world. A wide range of rock types is used as sources of building stone including sedimentary limestones and sandstones, metamorphic slates and marbles and some igneous rocks, principally granite. The suitability of a stone for building purposes depends not only on factors such as strength and durability, and commercial considerations such as the size of block or slab which can be extracted, but importantly on its aesthetic qualities, such as colour and texture. Desirable properties may also include being hard enough to resist years of weathering, but also soft enough to be polished, cut or carved. Most building stones are used locally, so differences in aesthetic properties such as colour or texture impart distinctive local character. In the past, rough dressed thinly-bedded sandstone slabs of Silurian, Devonian and Carboniferous ages have been used extensively, as has slate from North and South-west Wales, to impart local character to the vernacular buildings of the countryside of Wales. However, these contrast with the use of precisely cut blocks of imported stone (from England or further afield) such as granite or Portland Limestone, that impart grandeur to prestige buildings in cities such as Cardiff and Swansea.

The Mineral Resource Maps of Wales

The mineral resources data for Wales is presented on six maps at the 1:100 000 scale which collectively cover the whole country. The six map areas and the mineral planning authorities which they cover are:

South-east Wales, covering Blaenau Gwent, Brecon Beacons National Park Authority, Bridgend, Caerphilly, Cardiff, Merthyr Tydfil, Monmouthshire, Neath Port Talbot, Newport, Swansea, Rhondda Cynon Taff, Torfaen, Vale of Glamorgan, eastern Carmarthenshire and southern Powys;

South-west Wales covering Pembrokeshire, Pembrokeshire Coast National Park Authority, Carmarthenshire and southern Ceredigion

Mid Wales (South) covering southern Powys, north-east Carmarthenshire and Ceredigion

Mid Wales (North) covering northern Powys and southern Gwynedd

North-west Wales covering Anglesey, Gwynedd, Snowdonia National Park Authority, and western Conwy

North-east Wales covering eastern Conwy, Flintshire, Denbighshire and Wrexham

The mineral resource maps show both the superficial deposit resources and the bedrock resources. Where superficial deposit resources overlie bedrock, the outline of the bedrock resource is shown through the superficial deposit resource polygon as can be seen in Figure 2.

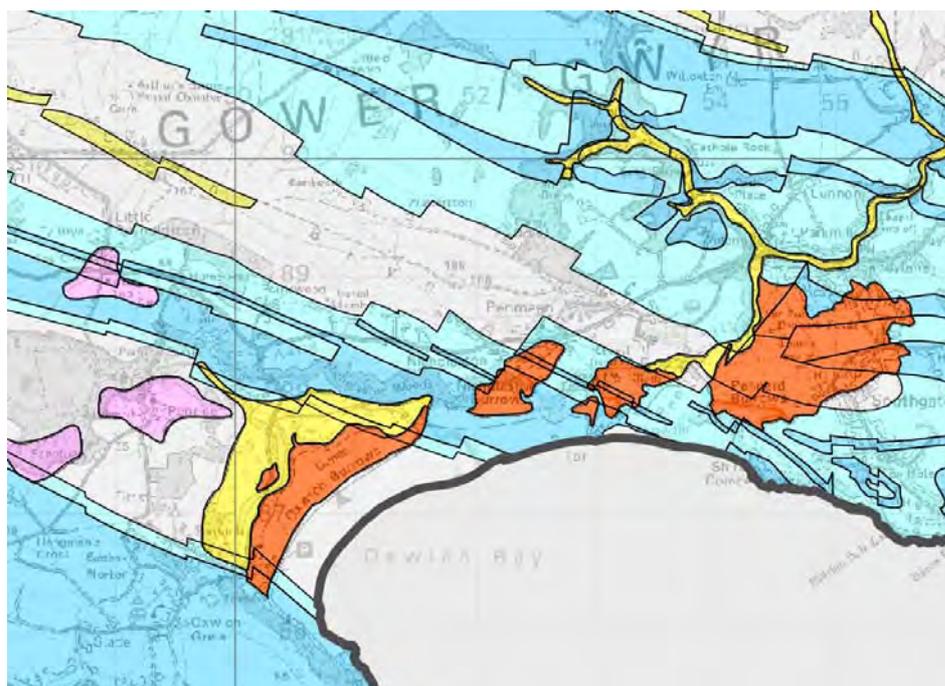


Figure 2. Illustration of bedrock resource underlying polygons of superficial deposit resource, showing the bedrock resource outline. Example taken from the South east Wales Mineral Resource Map, north of Port-Eynon; the outline of limestone mineral resources can be seen beneath superficial sand and gravel resources

Regional Mineral Resources Overview

The following sections provide a brief overview of each Minerals Map, highlighting the significant mineral resources in each area and their distribution.

South-east Wales

The mineral resources of south-east Wales are dominated by the presence of the South Wales Coalfield, within which occur the coal measures including the coal, brickclay and fireclay resources and the overlying Pennant sandstones, a hard sandstone which has properties that make it suitable for use as a high specification aggregate. Extensive opencast coal workings are present on the northern edge of the coalfield such as Ffos-y-fran near Merthyr Tydfil which is extracting steam coal for use at Aberthaw Power Station, Nant Helen and Selar and at East Pit at Gwaun cae Gurwen near Ammanford. Smaller deep drift mines are working at Johnson, Aberpergwm and Nant-Hir No. 2 collieries.

Bounding the coalfield to north and south is an outcrop of Carboniferous limestone. This has been extensively exploited in the past for lime and furnace flux, and is now worked mainly for aggregate, continuing to be exploited on both the north crop of the coalfield e.g. Penderyn, and along the south crop and northern Vale of Glamorgan e.g. Taffs Well and Cornelly. There are no longer workings in the Carboniferous limestone outcrops of the Gower peninsula or between Newport and Chepstow.

Younger Jurassic age limestone outcrops across the Vale of Glamorgan, usually in association with mudstone, and is being worked at Aberthaw for the purposes of cement manufacture.

The extensive quartzitic sandstone resource around the north crop is no longer being worked but remains an important mineral resource, as is the Devonian age Brownstones Formation in Monmouthshire where it has a lower micaceous content making it more suited for construction use. Sandstone from the Brownstones Formation is currently being worked in Gloucestershire.

Brick clay resources in Triassic age rocks are found west of Cardiff, where formerly extensive brickworks were present, although the industry declined and finished in the early 1980s.

Extensive spreads of onshore sand and gravel occur in the river valleys of South-east Wales, such as the Usk, Rhymney, Taff and Tawe valleys. At surface, sand and gravel may be present in the glaciofluvial deposits and river terraces, and can be inferred to be present beneath the alluvium of the modern river flood plain. Along the coast, extensive areas of blown sand are present in dune fields such as at Kenfig, whilst sandy tidal flat deposits above

low water mark are being worked at Bedwin Sands. Peat is present in the upland areas of the coalfield between Neath and Treorchy.

There are few recorded instances of significant metalliferous minerals in South-east Wales, although scattered ironstone, lead and copper is recorded in the Carboniferous limestone. Building stone quarries are found across the area, with particular concentrations in the Pennant sandstone and the limestone outcrops.

South-west Wales

South-west Wales includes the western edge of the South Wales coalfield (see above) and its westward extension, the Pembrokeshire coalfield, which has not been worked since the early half of the 20th century and is considered to be a less important shallow coal resource.

Carboniferous age sandstone and limestone are worked in south Pembrokeshire, and south of Fishguard and around St David's are extensive igneous and slate resources. Unlike North-west Wales, the slate industry had collapsed by the end of the 19th century, although slate waste and some slate is worked at Plaswrt.

North-eastwards into Ceredigion and east of Llandovery are outcrops of Silurian age sandstones which have potential for high specification aggregate usage although none in this area are currently being worked. Devonian age rocks were formerly worked for building stone between Milford Haven and Pembroke Dock.

Extensive glaciofluvial sand and gravel deposits occur along the valley of the Afon Teifi and in the Cleddau valleys north of Narberth and Haverfordwest although are not being worked. Sand and gravel is worked in the glacial deposits west of Cardigan. River terraces and sub-alluvial gravel in valleys such as the Aeron and middle Towy are also mineral resources. Blown sand occurs at Pendine and Freshwater West. Extensive peat development has occurred in the upper Teifi valley at Tregaron Bog, and blanket peat deposits are present in the uplands to the east and west.

Metalliferous mineral occurrences are relatively rare in Pembrokeshire and west Carmarthenshire, the few occurrences being associated with veins around the outcrop of igneous rocks, but north-eastwards occurrences of lead and zinc, with some barium and copper increase. Gold is present north-west of Llandovery. Nineteenth century slate workings were concentrated south and east of the Presceli Hills and along the coast north of St David's, whilst building stone quarries for local supply are scattered across the area.

South-west Wales also has workings in mudstone bedrock across Carmarthenshire and south Ceredigion although this material is suitable only for low specification uses and is not considered as a resource to be depicted on the minerals map.

Mid Wales (South)

North of the South Wales Coalfield, the significant bedrock mineral resources of southern mid Wales are the igneous rocks north of Builth Wells and the Silurian age sandstones with potential for high specification aggregates north of Garth (Cribarth Quarry), in Crychan Forest and north-east from Lampeter. Other Silurian and Devonian age sandstones are also present in relatively small outcrops across the area and in some cases are being worked for building stone and aggregate (e.g. Tredomen, Dolyhir).

Glaciofluvial and river terrace and sub-alluvial sand and gravel deposits occur in the valleys of the River Usk and River Wye and smaller spreads of glacial deposits occur elsewhere. Peat is present as blanket bog in the uplands of the Cambrian Mountains west of Rhayader.

Rare occurrences of metalliferous minerals (mainly lead) are recorded east of a line between Llandeilo and Rhayader but in the north-west of the area, more concentrated occurrences of mainly copper lead and zinc are known, this being the southern margin of the Central Wales Orefield. Scattered building stones quarries were once important for local supply, whilst a long thin outcrop of micaceous sandstones to the south east of a line between Llandeilo and Llandovery was once an important source of tile stones for roofing.

Mid Wales (North)

North of the Dovey estuary are extensive slate and igneous rock resources, the slate being worked at Aberlenni for slate slabs until recently. In the east of the area are further sandstone resources and extending from the south of the Silurian age sandstones which have potential for high specification aggregate usage. Igneous rocks are worked north-east of Welshpool at Criggion and Garreg. Limestone outcrops on the Welsh border west of the Shropshire village of Pant.

Glaciofluvial sand and gravel is again concentrated in the river valleys, the most extensive spreads occurring in the Severn valley between Newtown and Welshpool, although the Rheidol and smaller rivers draining westwards north of Aberystwyth also contain significant deposits. In the River Dovey and upper Severn valley, river terraces and sub-alluvial gravel deposits may be present. Blown sand occurs as dune fields along the coast to the north and south of the mouth of the River Dovey at Aberdovey and Ynyslas. Extensive blanket bogs provide a covering of peat in the Cambrian Mountains.

East of Aberystwyth extending towards Llanidloes is the main concentration of metalliferous mineral workings associated with the Central Wales Orefield. Extensively worked during the 19th and early 20th centuries, lead, zinc, silver copper, arsenic and barium are the main recorded minerals whilst north of Dolgellau, gold, antimony and copper mines are known.

There are many former slate quarries in the hills north-east of Tywyn and south of Harlech, and there are historic building stone quarries around Aberystwyth.

North-west Wales

North-west Wales is dominated by the slate and igneous rock resources of Snowdonia. Slate is still worked around Blaenau Ffestiniog and Penrhyn and south of Caernarfon, and the extensive waste tips associated with some of the largest slate quarries are being removed for aggregate usage. Igneous rocks are also worked on the Lleyn peninsula and on the Isle of Anglesey. Sandstones suitable for constructional and lower specification aggregate use are present east of Harlech, south of Bangor, on Anglesey and as smaller outcrops through Snowdonia. Quartzitic sandstones occur west of Holyhead. Carboniferous limestone is worked on Anglesey, and forms the Great Orme and hills around Colwyn Bay.

The most extensive sand and gravel deposits occur on the Lleyn peninsula north and west of Pwllheli as extensive spreads of glaciofluvial deposits. Blown sand occurs in dune fields on Anglesey and river terrace deposits are present in the Conwy valley at Llanwrst. Sand and gravel is inferred to be present beneath the alluvial tracts of the Conwy valley and the Vale of Ffestiniog. Extensive peat development has occurred in upland blanket bogs.

Metalliferous mineral occurrences are common in North-west Wales, copper and lead being common in central Snowdonia and lead, zinc, barium and manganese being worked on the Lleyn. Much of the mineralisation occurs in hydrothermal veins associated with the igneous rocks.

There are many disused slate quarries across the area and building stone quarries supplied not only local markets, but in the case of some of the igneous rocks, were more widely exported. Granite from quarries such as Gwylwyr and Porth y Nant on the Lleyn Peninsula specifically supplied stone setts to pave the streets of towns and cities in North-west England such as Liverpool and Manchester.

North-east Wales

The significant bedrock resources of north-east Wales are the Carboniferous age strata of the Flintshire coalfield with its coal, brick clay and fireclay resources and which extends from south of Wrexham to the Dee estuary. Coal is no longer mined in this area, but the coalfield remains an important resource for shallow coal and for new energy technologies. Important brick clay resources are present around Ruabon.

Quartzitic sandstone resources occur on the margins of the coalfield to the north of the Dee valley, and there are small outcrops of sandstone with potential for high specification aggregate usage north-east of Ruthin and east of Betws-y-coed. Around Ruthin, Triassic age sandstone has the potential to be crushed for use as sand and gravel.

Carboniferous limestone extends as two parallel outcrops southwards from the coast down either side of the Vale of Clwyd. Some of the limestone is high purity with non-aggregate (industrial) applications and is extensively worked south of Holywell.

Slate is worked north of Llangollen mainly for decorative uses and igneous outcrops were formerly worked north-west of Llanfyllin.

South-east of Wrexham is the western margins of the Cheshire salt basin and salt deposits are known to be present at depth between the Shropshire towns of Ellesmere and Whitchurch.

Extensive glaciofluvial sand and gravel deposits are present around Wrexham, in the Vale of Clwyd and in the Dee valley at Corwen, although the most significant working is at Wrexham. River terraces and sub-alluvial deposits in the Dee valley are also considered to be sand and gravel resources. Peat deposits again are present in the uplands.

Metalliferous mineral occurrences are less common across much of north-east Wales, although significant occurrences of lead and zinc are recorded in the limestone outcrop south of Holywell where mining occurred into the 20th century.

Historic building stone quarries are largely concentrated in the quartzitic sandstone outcrop between Wrexham and Llangollen.

Further Reading

Welsh Assembly Government. 2000. Mineral Planning Policy Wales. HMSO, Cardiff.

Welsh Assembly Government. 2004. Minerals Technical Advice Note (Wales) 1. Aggregates

Regional Aggregates Working Parties (RAWPS), established for South Wales and North Wales, have a membership drawn from the Minerals Planning Authorities, the aggregates industry and central government. The remit of the RAWPS is to provide information and guidance on planning and related issues concerned with the provision of aggregates in their region, such as the Regional Technical Statements (RTS) and Annual Monitoring Reports which monitor the supply of aggregate materials across their regions.

Mineral Planning Factsheets prepared by the British Geological Survey for a range of minerals produced across Britain are available for free download from www.MineralsUK.com