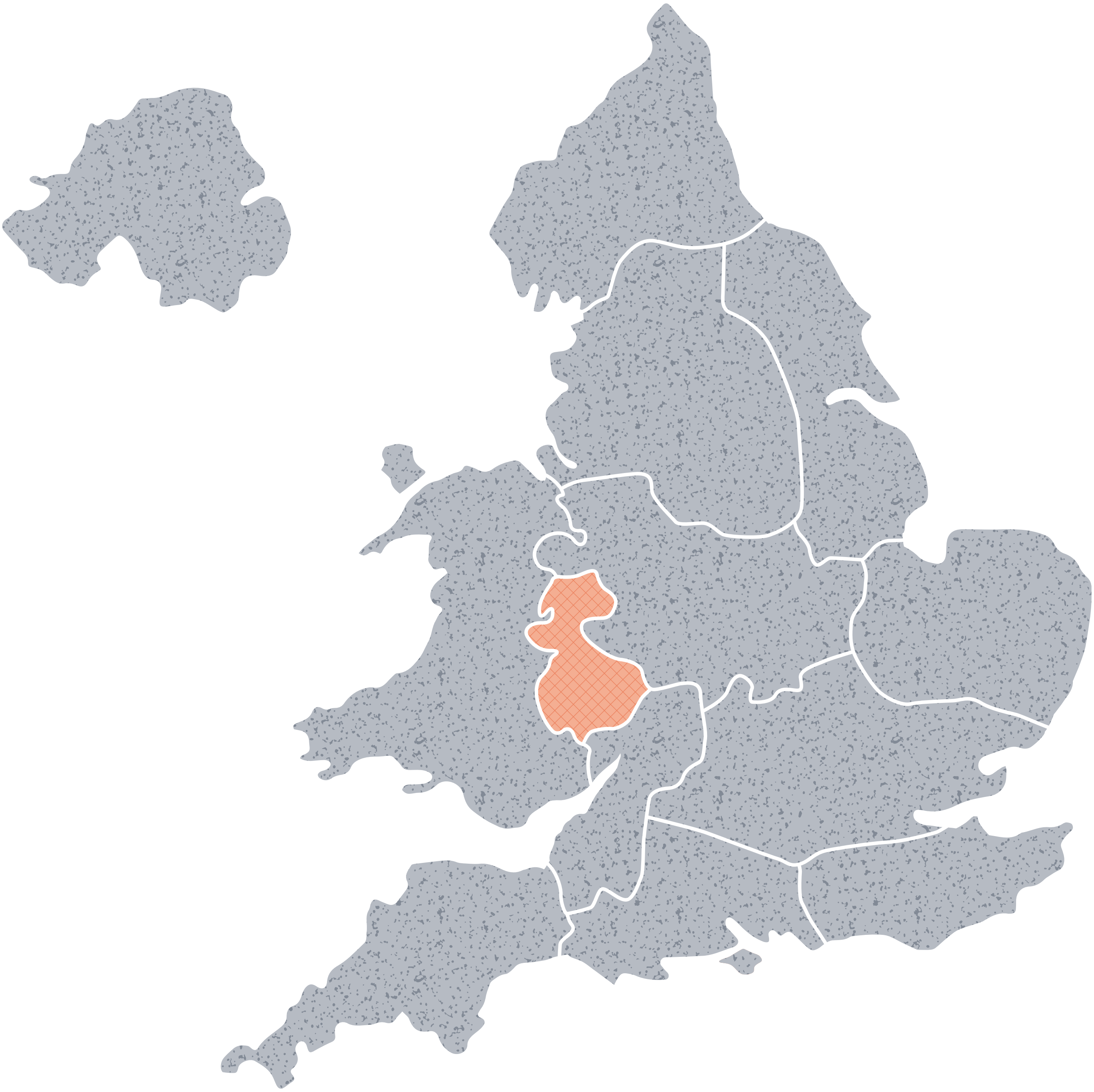
Radioactive Waste Management



The Welsh Borderland

RELEVANCE TO SAFETY

Contents

Clicking on words in green, such as sedimentary or lava will take the reader to a brief non-technical explanation of that word in the Glossary section. By clicking on the highlighted word in the Glossary, the reader will be taken back to the page they were on.

Clicking on words in blue, such as Higher Strength Rock or groundwater will take the reader to a brief talking head video or animation providing a non-technical explanation.

For the purposes of this work the BGS only used data which was publicly available at the end of February 2016. The one exception to this was the extent of Oil and Gas Authority licensing which was updated to include data to the end of June 2018.

Our work shows that we may find a suitable geological setting for a GDF in a small part of this region, but the thickness and properties of the potential host rocks present may not be suitable.

Rock can be seen at the surface in some of the subregion such as the Malvern Hills and in man-made excavations such as quarries or road cuttings. Combined with some deep boreholes and geophysical investigations, this gives us an understanding of the rocks present and their distribution.

There are clay-rich rock layers, in which we may be able to site a GDF, to the north of Shrewsbury and to the south of Worcester. We would need to do more work to find out whether these rocks have suitable properties and thicknesses.

Even where individual clay-rich rock layers are found not to be thick enough to host a GDF they may support the siting of a GDF in deeper rocks as they could act as a barrier to groundwater flow from depth. This is important because movement of groundwater is one of the ways in which radioactive material could be carried back to the surface.

Some of the subregion has been mined to depths below 100m for coal resources, to the south-west of Shrewsbury, and lead, zinc and barite, to the north of Bishop’s Castle. In these areas the mining is likely to have affected the way in which water moves through the rock. Also possible exploration in the future in these areas means that it is more likely that future generations may disturb a facility.

Introduction

The Welsh Borderland region is adjacent to Wales and the Bristol and Gloucester and Central England regions.

Rock type

Figure 1 shows where in the region there are likely to be Lower Strength Sedimentary Rocks (LSSR) within the depth range of interest, there are no Higher Strength Rocks (HSR) or Evaporites in the subregion. The rocks comprise younger and older sedimentary rocks overlying a range of sedimentary, metamorphic and igneous basement rocks. There are only 2 areas with potential LSSR:

- Mercia Mudstone Group of Triassic age (approx. 200 to 250 million years old) occurs in the depth range of interest in the east of the region around Worcester. This is the edge of a large area of this rock, extending into the Central England and Bristol and Gloucester regions. In the Welsh Borderland region they are only present in the uppermost part of the depth range of interest and are unlikely to provide a suitable volume to host a GDF. It is also possible that they could provide a barrier to groundwater flow from depth and so contribute to the safety of a GDF hosted in underlying rocks, but in this region these are predominantly sandstones which are too permeable to be potential host rocks.
- The other area of potential LSSR in the region is in the north near Shrewsbury, and the rocks identified here are part of the Warwickshire Group of Carboniferous age (approx. 300 to 360 million years old). In this region however, the group is dominated by sandstones and siltstones rather than the mudstones which could comprise LSSR. Only the uppermost part of the Group is dominated by mudstones and this occurs mostly above the depth range of interest in this region. It is therefore considered unlikely that this small area of potential LSSR would have suitable properties to contribute to the safety of a GDF.

Although some of the basement rocks may have properties that would make them potential HSR, they are intensely broken up by faults and fractures, providing many potential pathways for groundwater movement towards the surface.

A summary of the geological attributes of the Welsh Borderland region can be found here, including a simplified rock column showing the oldest and deepest rocks at the bottom, with progressively younger rock units towards the top.

Rock structure

The Welsh Borderland region is crossed by a series of major faults and fault zones (Figure 2). There are a number of faults with significant displacements but those with the largest displacements are the Malvern Lineament and the Welsh Borderland Fault System including the Church Stretton Fault and Pontesford Lineament in this region. They are not simple faults, and the rock masses along them are often cut by minor faults and shears. Faults may act as barriers to or pathways for groundwater movement, depending upon their characteristics, and the siting of a GDF would need to take account of them[1].

In addition to faulting, there are a series of relatively open folds affecting Carboniferous and older rocks. The folding is not as intense as that which affects rocks of the same age in Wales. As a result, the basement rocks, which have been folded and metamorphosed to form slates in Wales, are not slaty in the Welsh Borderland, and are therefore not likely to have potential as HSR host rocks in this region.

Groundwater

There is very little information on groundwater in the depth range of interest for a GDF, 200 to 1,000m below NGS datum, although there is information on groundwater in aquifers above 200m. In the far north and the east of the region, the Sherwood Sandstone of the Cheshire Basin and Worcester basin respectively are present within 400m of the surface and are principal aquifers. A number of rock units are less permeable than these rocks and probably act as barriers to water movement. These include the Mercia Mudstone and Warwickshire Group LSSR, even where they are not thick enough to host a GDF, and some Precambrian igneous and sedimentary basement rocks. However, many of the basement rocks occur in steeply-dipping bodies and may not cover a large enough area to effectively limit vertical movement of groundwater. Groundwater from depths greater than 400m is unlikely to be suitable as drinking water anywhere in the UK[2].

Mining for coal and for metal ores in parts of the region is likely to have changed the original patterns of water movement, and shallow groundwater may circulate to greater depths within the depth range of interest now than it did before mining. There are no concentrations of deep exploration boreholes in this subregion or thermal springs to suggest rapid flow of deep groundwater to the surface.

[1] Faults occur on a diverse range of scales, from centimetres to kilometres, and the subsurface is criss-crossed by networks of numerous individual faults. However our work includes only those faults identified by the BGS with throws (vertical offset) of 200m or more. This is because the data available to the BGS are not able to resolve all faults consistently, across all thirteen regions, with throws less than 200m. We recognize the potential importance of smaller scale faults to the integrity of a GDF and will need to survey them in detail as part of the site evaluation process.

[2] Water Framework Directive UK TAG. Defining and reporting on groundwater bodies, 2012.

Resources

To the north of Bishop's Castle there are abandoned lead, zinc, and barite mines, some of which penetrated deeper than 100m (Figure 3a) and coal has been mined below 100m to the south-west of Shrewsbury (Figure 3b). In these areas the mining is likely to have affected the way in which water moves through the rock. Also possible exploration in the future in these areas means that it is more likely that future generations may disturb a facility. These known resources would be taken into account in the siting of a GDF.

The full extent of the historic Shropshire Orefield is also shown in Figure 3c but is not relevant to the siting of a GDF as the mines are shallower than 100m.

Natural processes

Earthquakes and glaciations are unlikely to significantly affect the long-term safety of a GDF in the UK. Therefore, whilst a GDF would need to be sited and designed to take account of natural processes which may occur during its lifetime, they are not considered further as part of this screening exercise.

Figure 1 The areas of the Welsh Borderland region where Lower Strength Sedimentary Rock Types of Interest are present between 200 and 1,000m below NGS datum.

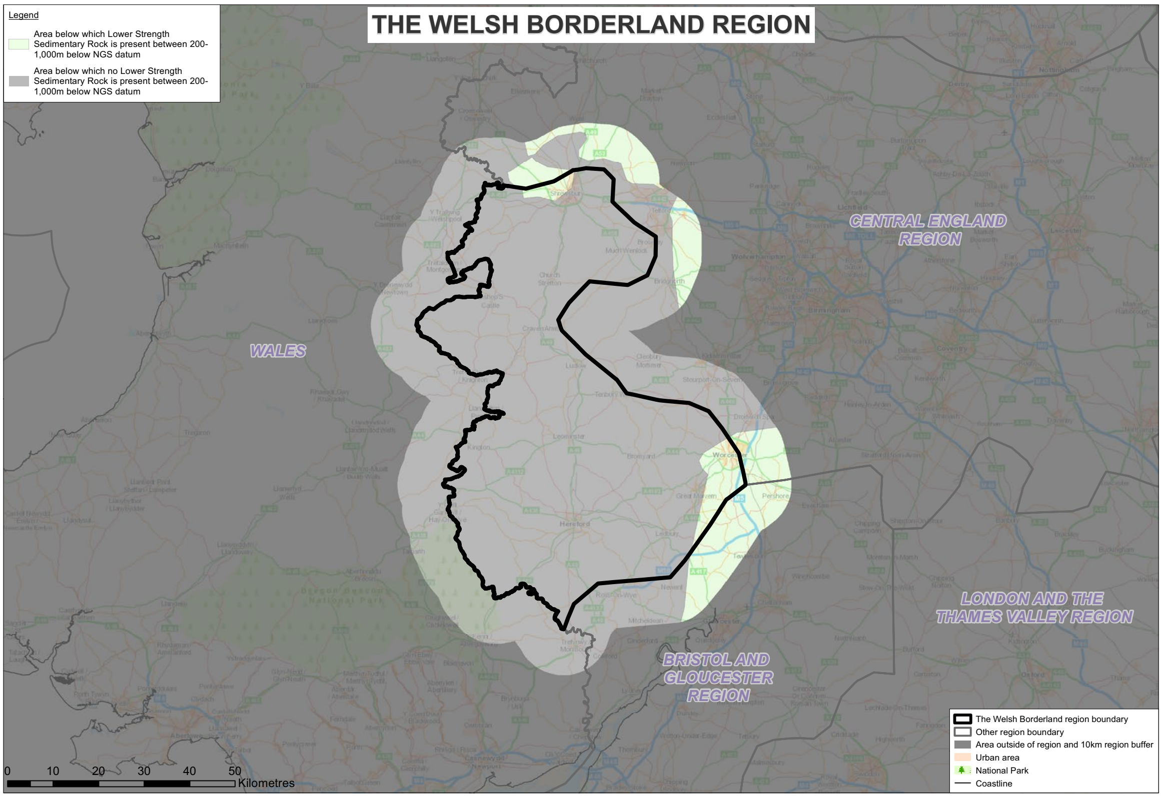


Figure 2 Location of major faults and areas of folding in the Welsh Borderland region.

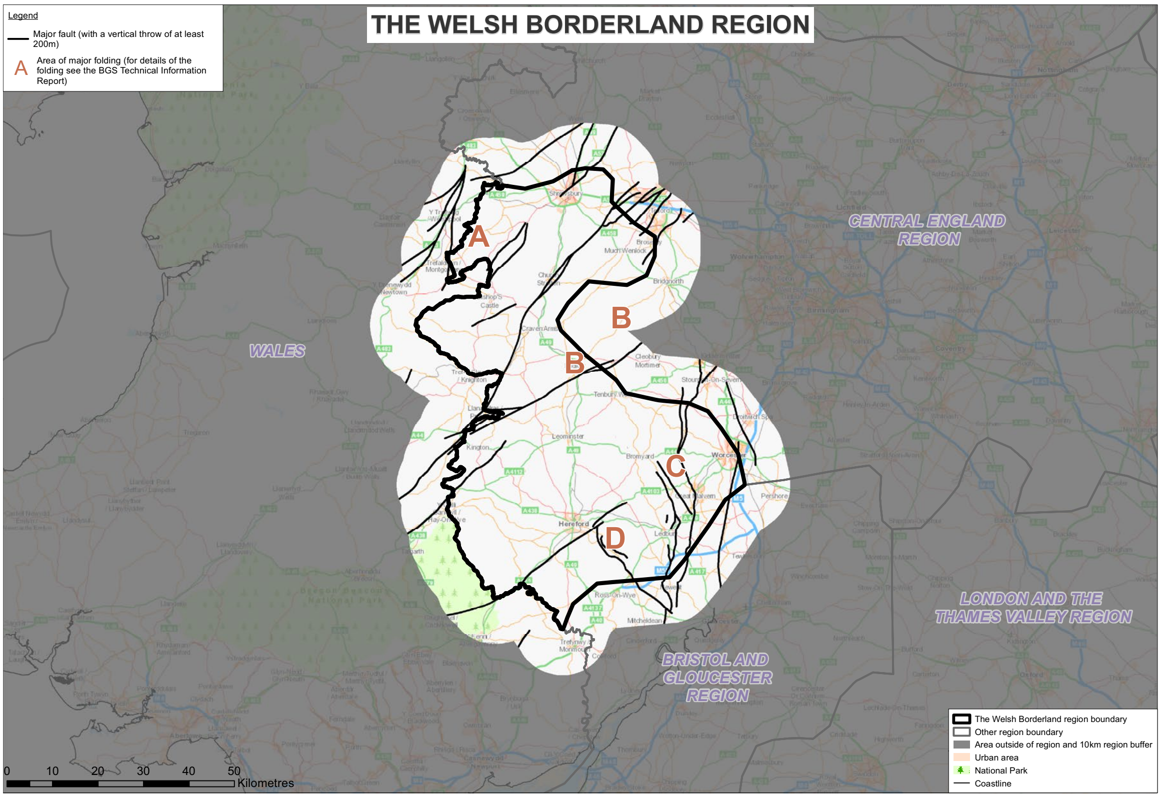


Figure 3a Areas of the Welsh Borderland region with metal and vein mineral mines present below 100m.

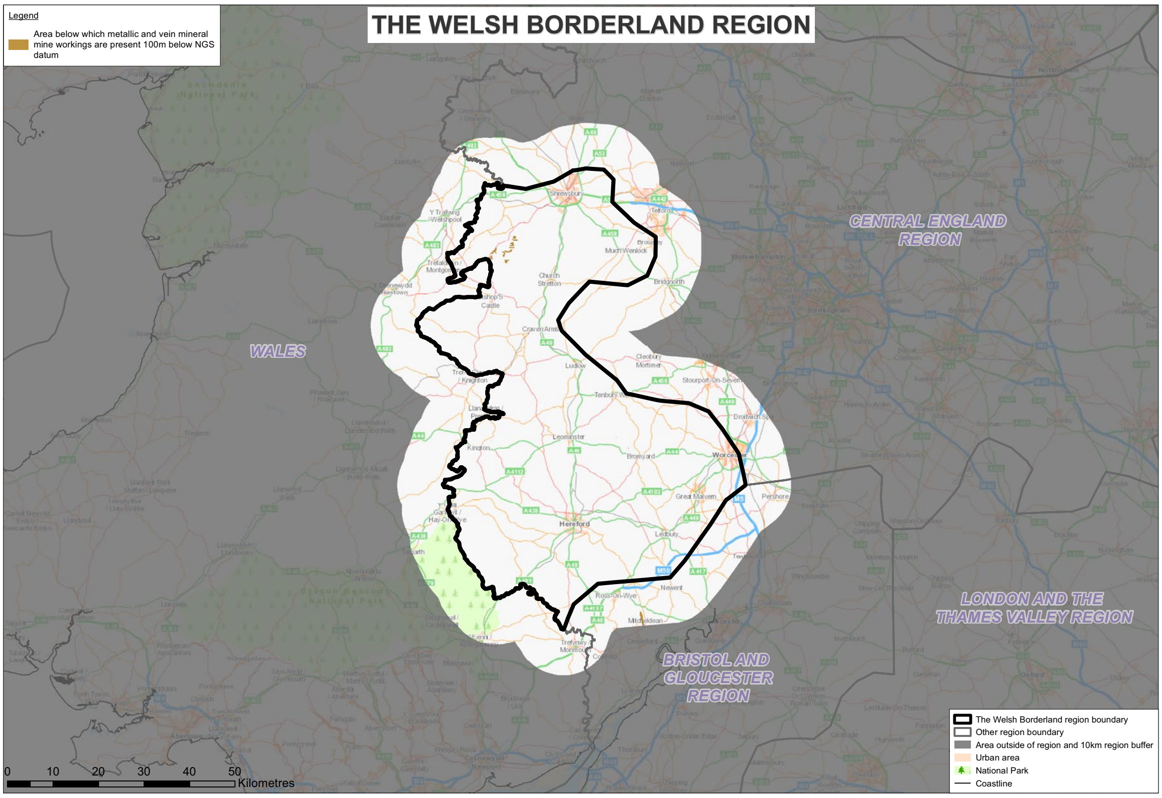


Figure 3b Areas of the Welsh Borderland region with coal mines present below 100m.

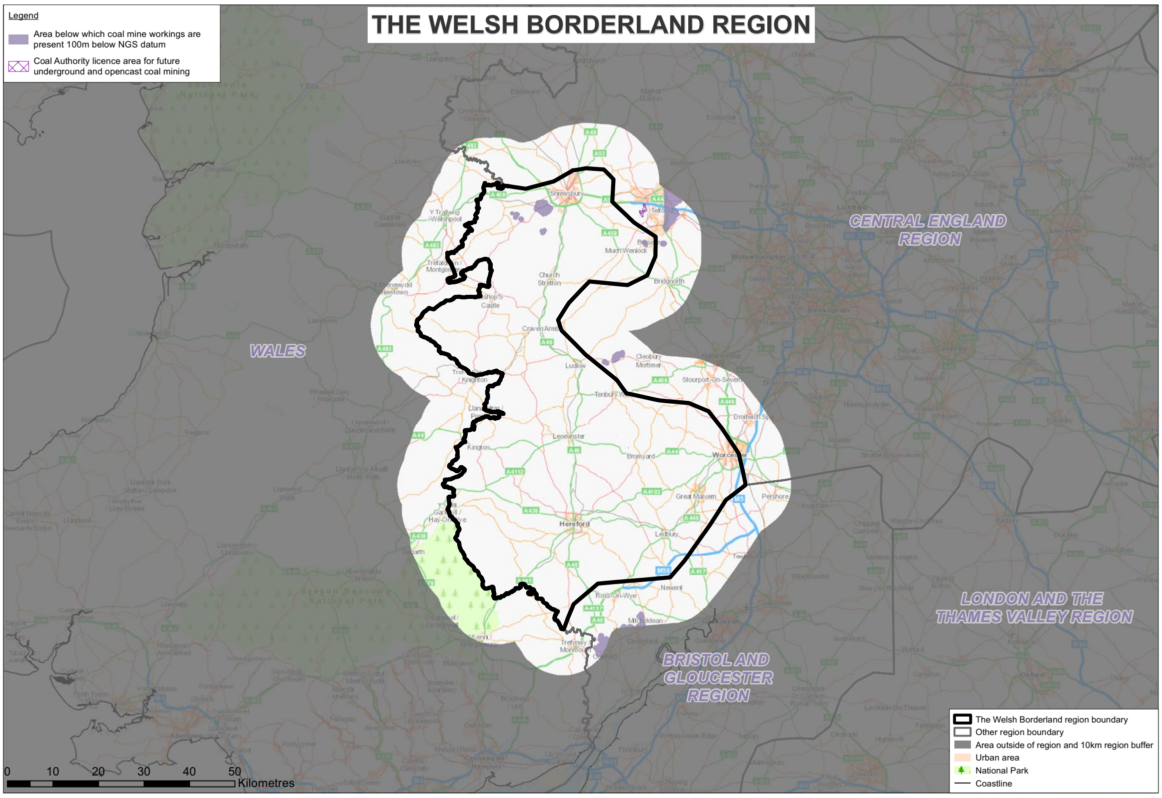
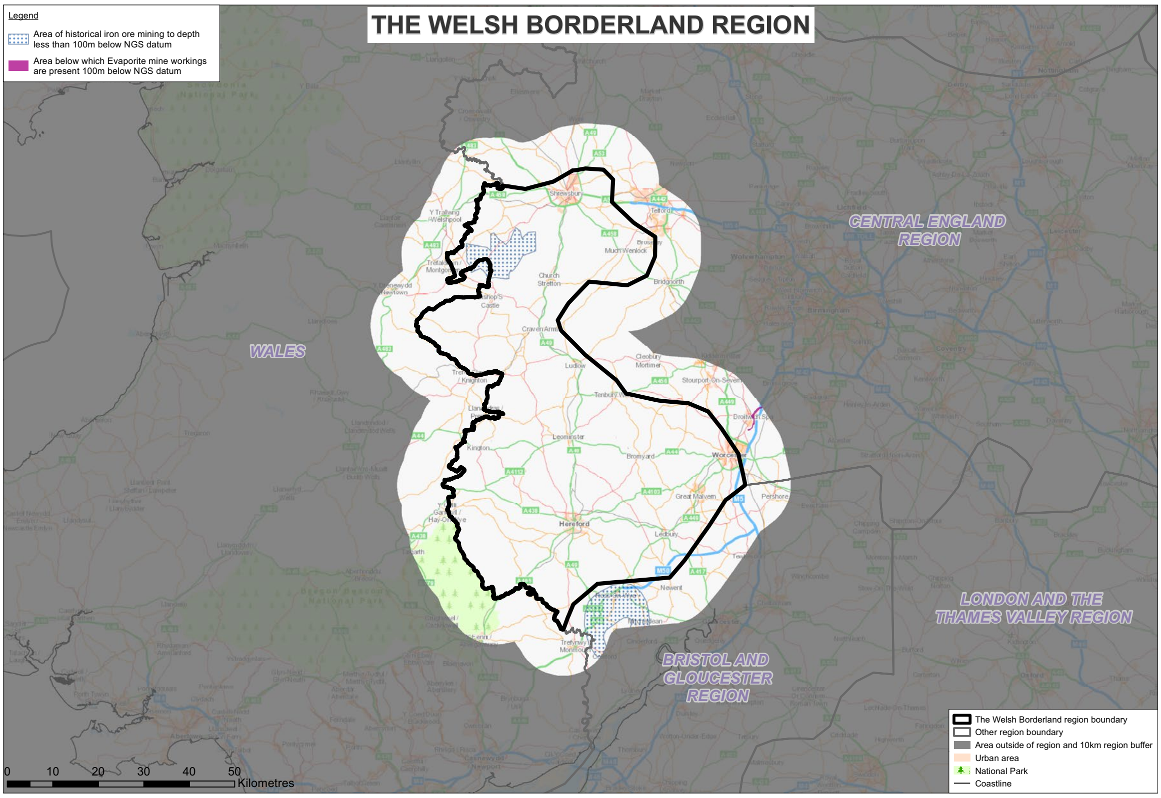


Figure 3c Areas of the Welsh Borderland region with historical metal and vein mineral mines less than 100m deep.



Glossary

Aquifers
Aquifers are rocks that contain freshwater in pores and/or fractures and whose porosity and permeability are sufficiently high to make the extraction of groundwater possible.

Fault
A fracture in the earth's crust across which the rock layers each side of it have been offset relative to one another.

Fracture
A crack in rock. Fractures can provide a pathway for fluids, such as groundwater or gas, to move in otherwise impermeable rock.

Igneous
One of three main rock types (the others being sedimentary and metamorphic), consisting of hard, dense rocks made up of interlocking crystals. They form due to cooling of magma deep within the crust beneath volcanoes, or as lavas erupted at the surface.

Metamorphic/metamorphosed
A rock that has undergone change due to the action of temperature and pressure.

Principal aquifers
An aquifer classified by the Environment Agency as: "rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage." They represent the most important aquifers in terms of water supply or base flow.

Sedimentary
A type of rock resulting from the consolidation of material that has accumulated in layers to form gravel, sandstone, mudstone and limestone. The layers may be built up by movement from erosion (e.g. by rivers, the sea or wind) or by chemical precipitation. Generally, the material that accumulates has originated from the weathering of other rocks. Sedimentary rocks constitute one of the three main classes of rocks identified by geologists, the others being igneous and metamorphic.

Slaty
Distinctive way in which slate rocks split into very fine sheets.

Radioactive Waste Management

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