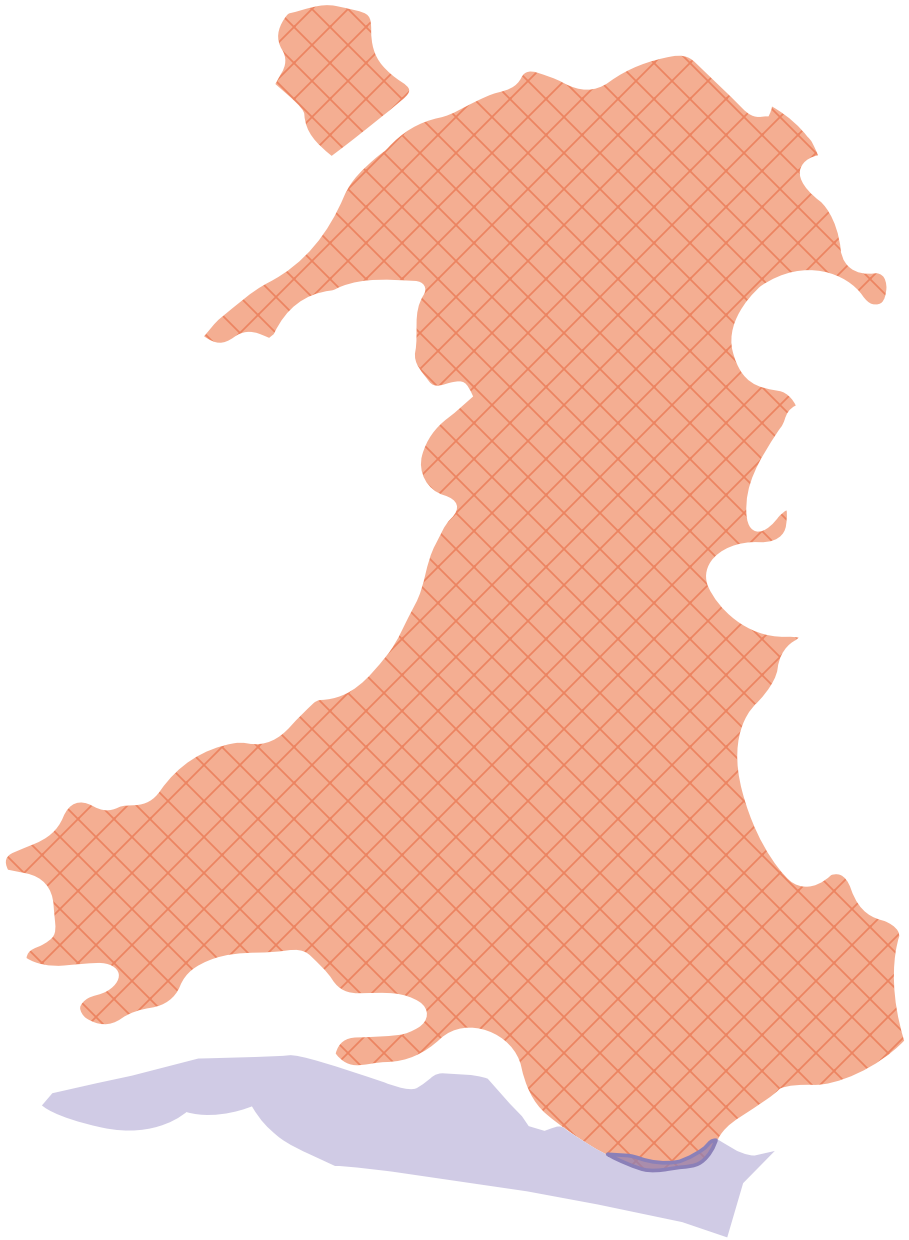
Radioactive Waste Management



# Wales

## SUBREGION 4

# 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 most of this subregion.

Given that most of this subregion is the inshore which extends to 20km from the coast, no rock can be seen at the surface but a small number of boreholes and geophysical investigations give us an understanding of the geology at depth.

There are clay-rich rock layers under most of the subregion in which we may be able to site a GDF. There are also layers of rock salt under most of the southern half of the subregion in which we may be able to site a GDF. 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.

There are no known coal, oil, gas or metal resources in this subregion which means that it is unlikely that future generations may disturb a facility.

## Introduction

The Bristol Channel subregion comprises the inshore strip off the south coast of Wales from near Cardiff to the Gower Peninsula, extending to 20km from the coast to the south of Carmarthen Bay.

## Rock type

Figures 1a to 1c show where in the subregion there are likely to be Rock Types of Interest for the development of a GDF within the depth range of interest. The Lower Strength Sedimentary Rocks (LSSR) of interest in this subregion are part of the younger sedimentary cover. They comprise Jurassic sedimentary rocks (approx. 145 to 200 million years old) ranging from the Upper Jurassic to the Lias Group, as well as the underlying Mercia Mudstone Group, becoming progressively thicker further from the coast.

The Upper Jurassic Kimmeridge Clay Formation attains a thickness of over 300m in parts of the Bristol Channel and overlies the Upper Jurassic Ampthill Clay Formation. The partly equivalent, Middle to Upper Jurassic Ancholme Group is also present in the western part of the subregion and contains significant thicknesses of mudstone. These Middle and Upper Jurassic mudstones are likely to contain thick units suitable to act as the host rock for a GDF and, where present, also provide a barrier to the movement of groundwater.

The Lias Group is known from extensive outcrops in the Vale of Glamorgan (outside this subregion), a few boreholes off the coast and from geophysical seismic surveys. It contains mudstones and calcareous mudstones interbedded with limestones. The individual mudstones are unlikely to be thick enough to act as a host rock, but the Lias Group provides an effective barrier to the movement of groundwater from depth towards the surface.

The Mercia Mudstone Group occurs beneath the Jurassic rocks and within the depth range of interest over much of this subregion. It becomes thicker away from the coast and to the west. The Mercia Mudstone Group is dominated by dolomitic mudstones and siltstones, with gypsum also present in veins and nodules and rock salt (halite) layers are also likely to be present. The mudstone units are known to act as a barrier to groundwater movement and may have the potential to act as LSSR host rocks, since they form thick homogeneous units of low permeability and the BGS have identified the rock salt layers as potential Evaporite host rocks.

Although not recognised by the BGS as a Rock Type of Interest, the intervening Penarth Group also contains some mudstone layers and is likely to provide further separation between the Mercia Mudstone Group and the seabed.

Subsurface engineering in mudstones can be challenging because they are relatively weak. Where these mudstones occur in the lower part of the depth range of interest the constructability of a GDF would be considered during the siting process.

A summary of the geological attributes of Wales 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 younger sedimentary cover in this subregion occupies an east-west rift basin, the Bristol Channel basin, which formed during the Triassic and Jurassic, between roughly 230 and 150 million years ago. Its formation was largely controlled by major faults, some of which were later reactivated by compressive forces to form large folds, especially toward the east of the subregion (Figure 2). However given that this subregion is located mostly inshore, the level of detail to which it is possible to map major structures is significantly less than onshore and we would need to carry out a more detailed investigation as part of site evaluation. Faults may act as barriers to or pathways for groundwater movement, depending upon their characteristics, and these would need to be considered during the siting of a GDF [1].

### Groundwater

There is very little information on groundwater in the depth range of interest for a GDF, 200 to 1,000m below NGS datum. The Sherwood Sandstone Group and the Carboniferous Limestone aquifer are present at depth in this subregion. In some other regions these rocks occur onshore at shallow depths and are principal aquifers. In this subregion they are only present off the coast where the water in the pores of rocks beneath the seabed is saltwater rather than fresh and they are not therefore suitable for use as aquifers. Carboniferous Limestone aquifer underlies the Triassic rocks in part of the subregion.

There is no information about deep groundwater behaviour in this subregion, but it is likely that the numerous LSSR layers in this subregion separate the deep groundwater from the seabed, even where they are not thick enough to host a GDF.

There are no concentrations of deep exploration boreholes in this subregion or thermal springs to suggest rapid flow of deep groundwater to the surface.

### Resources

There are no known resources in this subregion and therefore the likelihood of future human intrusion is considered to be low.

### 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.

[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..

**Figure 1a** The areas of Wales subregion 4 where any of the 3 Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

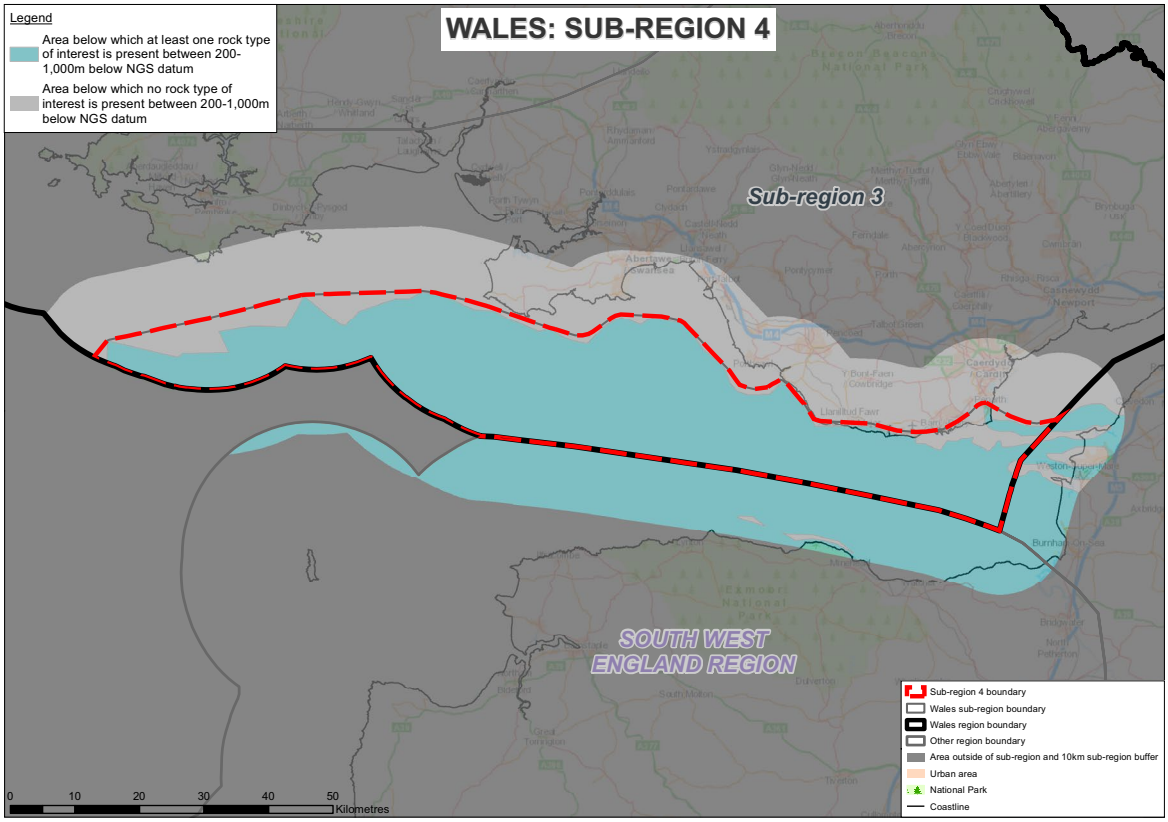



**Figure 1b** The areas of Wales subregion 4 where Lower Strength Sedimentary Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

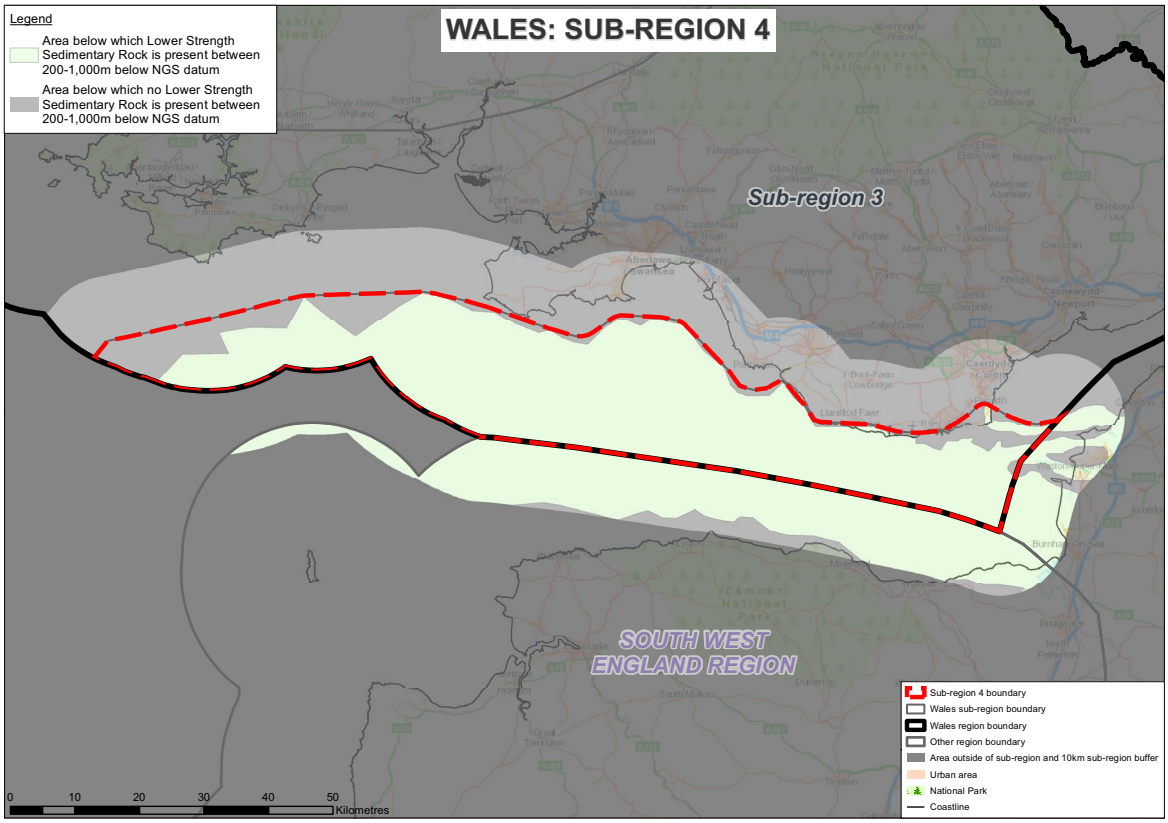


**Figure 1c** The areas of Wales subregion 4 where Evaporite Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

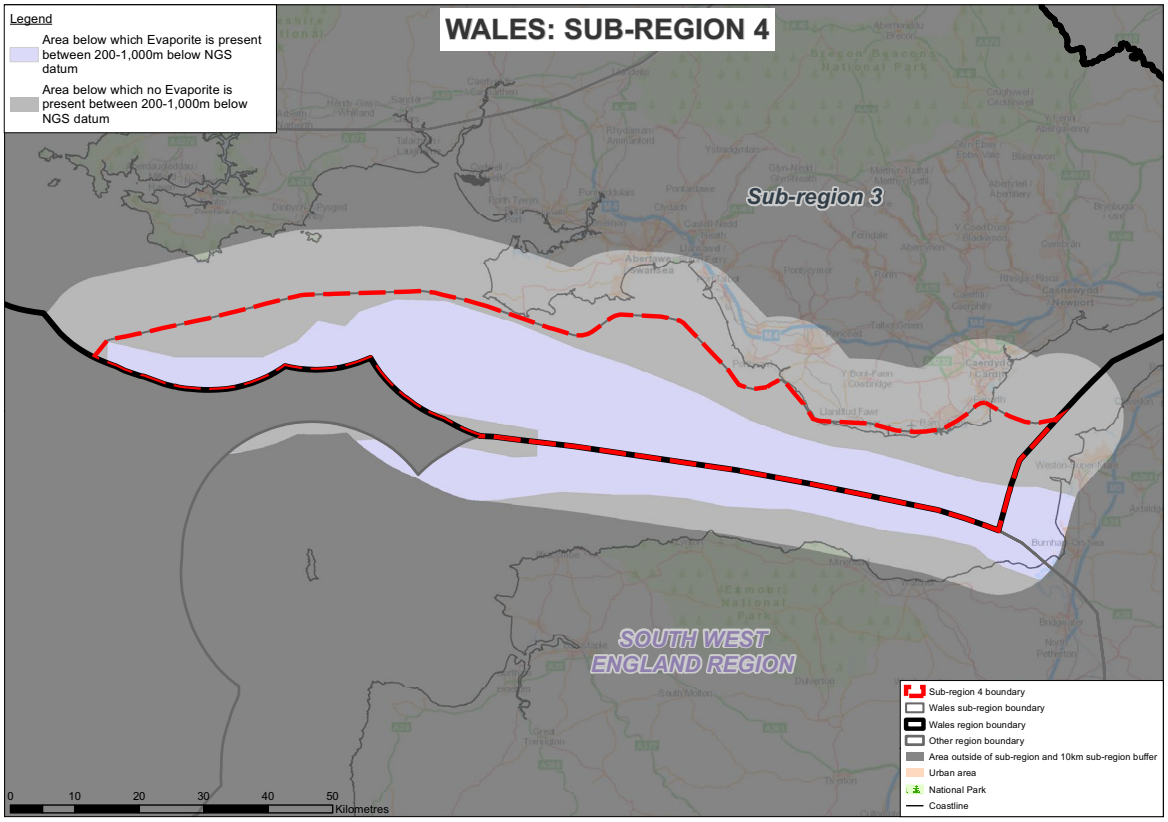
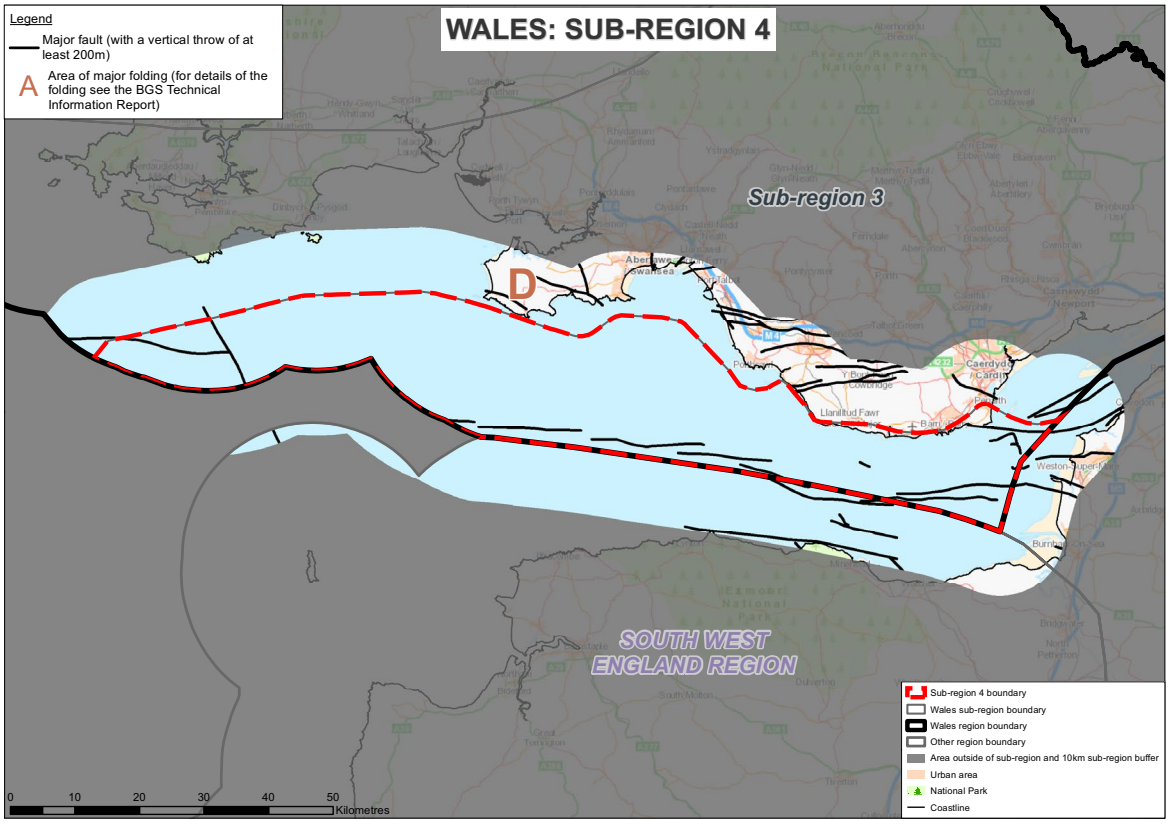



**Figure 2** Major faults and areas of folding in Wales subregion 4.



# 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.

### Gypsum
A calcium sulphate mineral that forms from the evaporation of salty seas. It contains water and occurs at shallower depths and lower temperatures than anhydrite.

### Halite
A sodium chloride evaporite mineral that forms when salty water dissolves. Also known as rock salt, or just 'salt'.

### Nodules
Small, often irregular mineral precipitations found within sedimentary rocks. They usually have a contrasting composition to the rock in which they are found e.g. flint nodules in chalk.

### Outcrop
A visible exposure of bedrock on the surface.

### 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.

### Seismic survey
Geophysical method that produces an image of the subsurface by transmitting shock waves, or seismic energy, into the ground and measuring the pattern of energy that is reflected back to the surface. Widely used by the resource industries to provide information on the composition and structure of the underground geology.

### Veins
Sheet-like accumulations of minerals that have been intruded into fractured rock. Commonly they are made up of quartz or calcite crystals but can also contain small concentrations of precious metals.

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