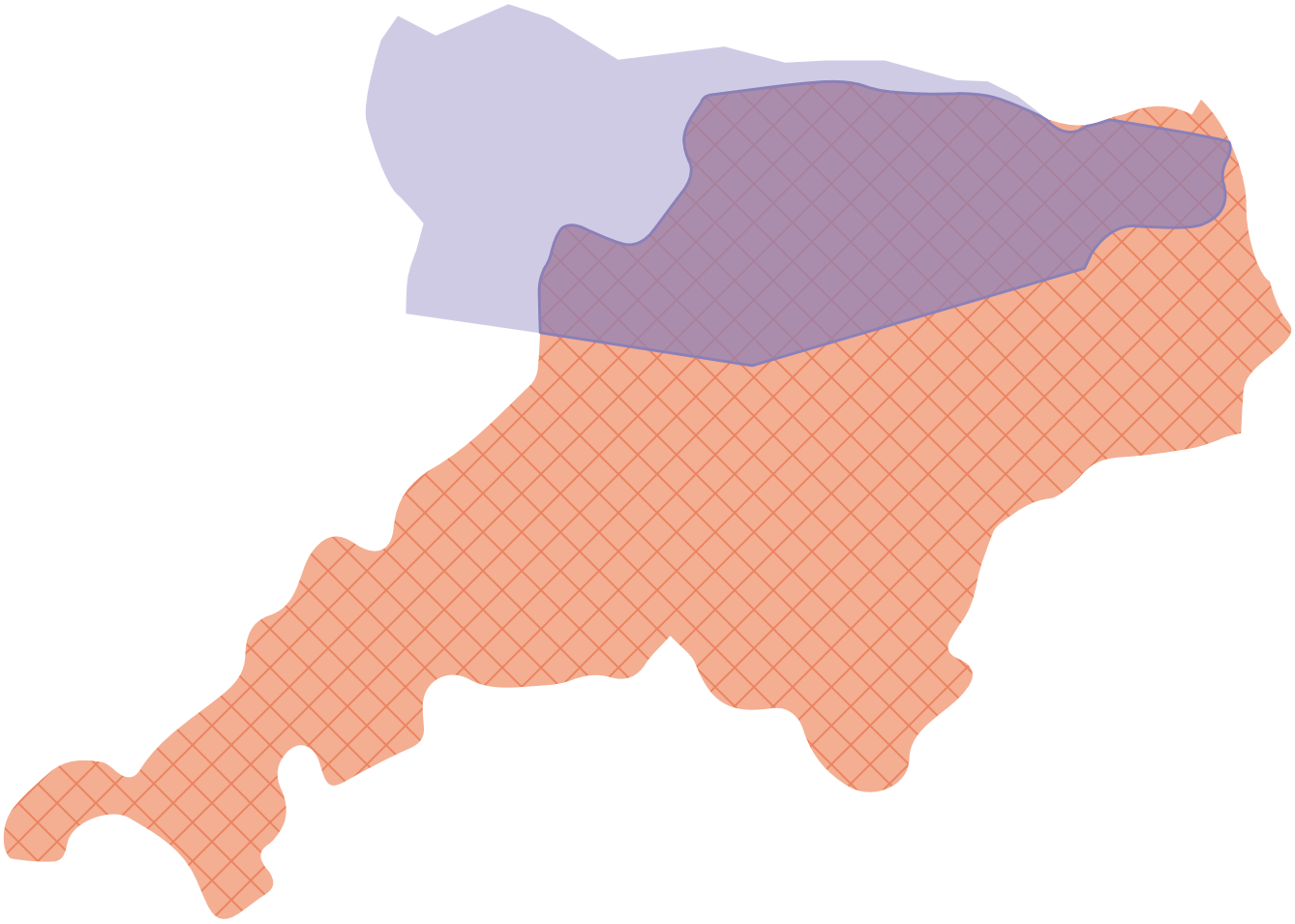
Radioactive Waste Management



South West England

SUBREGION 2

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.

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

There are slates and similar strong rocks under the whole 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.

Some of the subregion has been mined to depths below 100m for lead and silver resources, north of South Molton and in the east of Exmoor. 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.

An area along the northern edge of this subregion between Minehead and Bridgwater has Petroleum Exploration and Development Licences to allow companies to explore for oil and gas. This exploration is currently at an early stage and it is not known whether oil or gas in these licence areas will be exploited. RWM will continue to monitor how this exploration programme progresses.

Introduction

This subregion comprises an area north of a line from Bude to Tiverton. It includes the adjacent inshore area which extends to 20km from the coast to the west but excludes much of the inshore area further east which is included in subregion 1.

Rock type

Figures 1a to 1d 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 geology of the depth range of interest is dominated by 2 main groups of basement rock:

- Carboniferous rocks (approx. 300 to 360 million years old). There are few boreholes and the distribution of the different rock units at depth is not well known. Many of these rocks contain frequent sandstone layers, interbedded with slates on a scale of a few metres and are intensively folded throughout often with faults and fractures linked to the folds. As a result they are unlikely to be suitable to host a GDF. However, the Lower Carboniferous Teign Valley Group and Tintagel Group are more uniform and are potential Higher Strength Rocks (HSR). In these groups, slaty mudrocks predominate, with more siliceous cherty mudrocks and occasional limestones above and slaty mudrocks with metamorphosed volcanic rocks below.
- Devonian rocks (approx. 360 to 420 million years old). There is considerable variation in detail across the subregion but the Devonian rocks may be several hundred metres thick. The Upper Devonian rocks include sandstones as well as slates; however the slate units may be many hundreds of metres thick. Middle Devonian rocks also include thick slates as well as sandstone units. Lower Devonian rocks occur on the coast at Lynton and also include thick slate units, which extend south beneath much of Exmoor within the depth range of interest. These slates are likely to act as a barrier to groundwater movement and have the potential to act as HSR host rocks, where they are sufficiently thick.

There is also a very small area of sedimentary rocks of Eocene to Oligocene age (approx. 25 to 55 million years old) in the Petrockstowe Basin to the south of Great Torrington which the BGS have identified as potential Lower Strength Sedimentary Rocks (Figure 1b).

There is also an inshore area to the north of Lundy which may have rock salt (halite) layers of the Mercia Mudstone Group within the depth range of interest (Figure 1d). However there is very little information available and the rock salt may be too thin to be suitable to host a GDF this far west. Further details can be found under subregion 1 of this region.

A summary of the geological attributes of the South West England 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

There are several major faults, including the Sticklepath Fault which cuts south-east to north-west through the subregion, and areas of major folding in this subregion (Figure 2). 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].

The Devonian and Carboniferous rocks are intensely folded. This intense folding varies systematically across the subregion, although the folds are generally aligned east-west. As a consequence of this folding the dip of the rock layers varies considerably over short distances and this would complicate the search for volumes of uniform rock.

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. There are no principal aquifers in this subregion. Water is mainly extracted from wells that are no more than a few tens of metres deep, and the main sources are the sandstone units. Groundwater flow in the Carboniferous and Devonian basement rocks is likely to be dominated by fractures. These are often related to faults and folds, although their abundance also varies between sandstones and slates; most are only likely to be open to groundwater flow within a few tens of metres of the surface. Groundwater from depths greater than 400m is unlikely to be suitable as drinking water anywhere in the UK[2].

There are no low permeability clay-rich rock layers in most of this subregion to act as barriers to vertical flow between deep and shallow groundwater.

In parts of the subregion mining is likely to have changed the original patterns of water movement and shallow groundwater may now circulate to greater depths within the depth range of interest than it did before mining. There are also 2 small areas in the subregion where deep exploration boreholes may influence the connectivity between shallow and deep groundwater which would need to be considered during the siting process (Figure 3). There are no thermal springs in this subregion 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

There are a small number of lead and silver mines below 100m in this subregion (Figure 4a). 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.

Petroleum Exploration and Development Licences are currently held for an area along the northern edge of this subregion between Minehead and Bridgwater (Figure 4b). It is not known whether oil or gas in this licence area will be exploited, but it would need to be considered in the siting of a GDF.

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 1a The areas of the South West England subregion 2 where any of the 3 rock types of interest are present between 200 and 1,000 m below NGS datum.

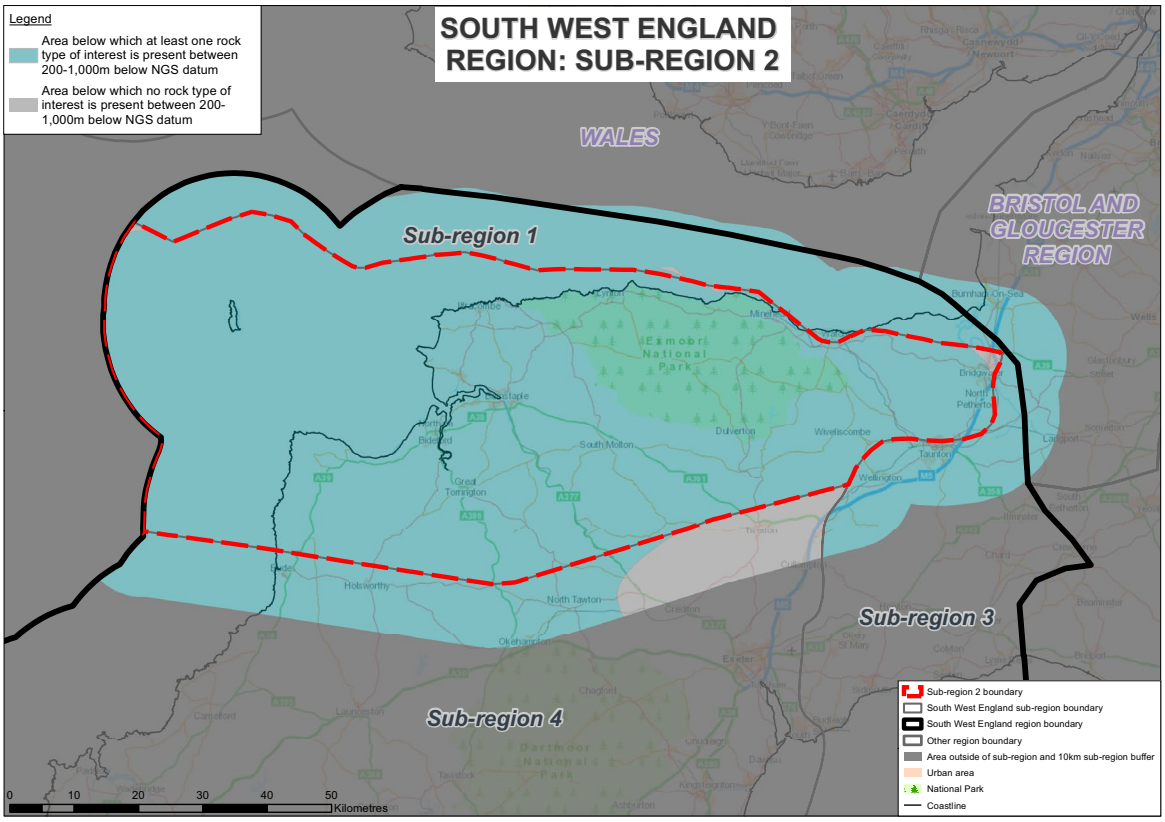


Figure 1b The areas of the South West England subregion 2 where Lower Strength Sedimentary Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

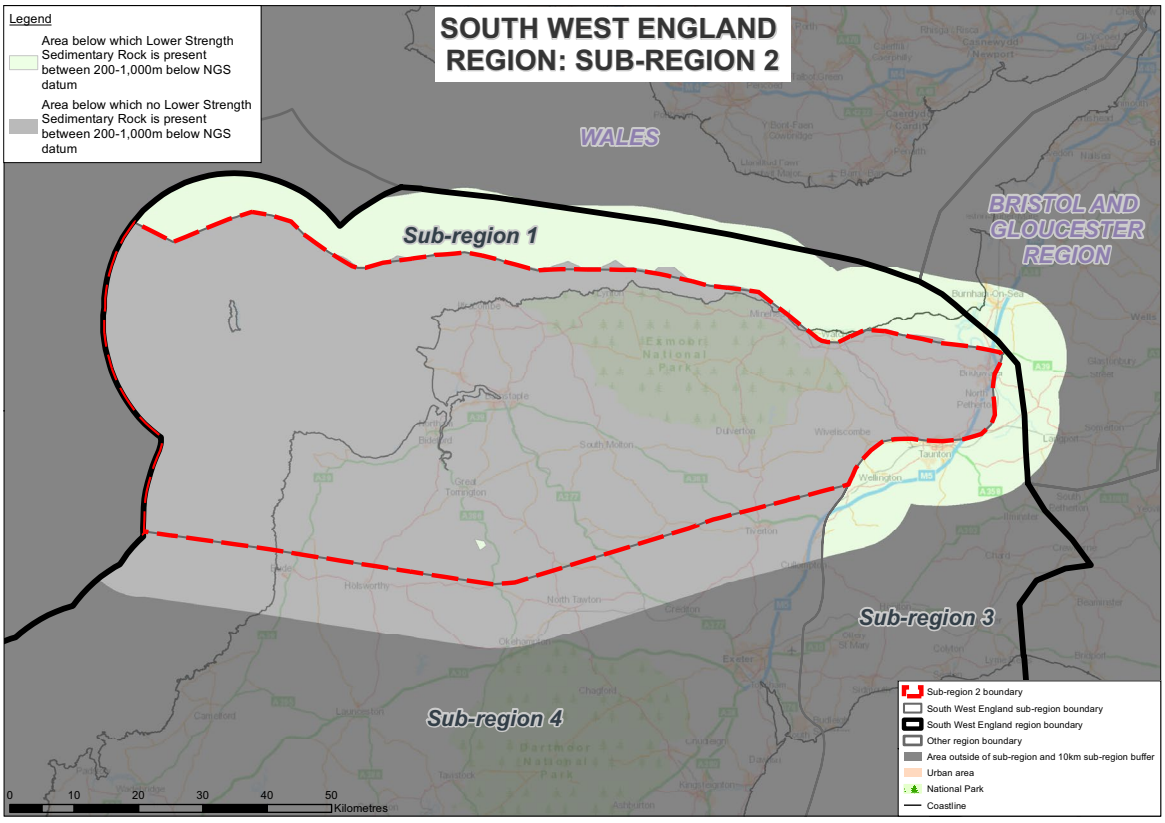


Figure 1c The areas of the South West England subregion 2 where Higher Strength rock types of interest are present between 200 and 1,000 m below NGS datum.

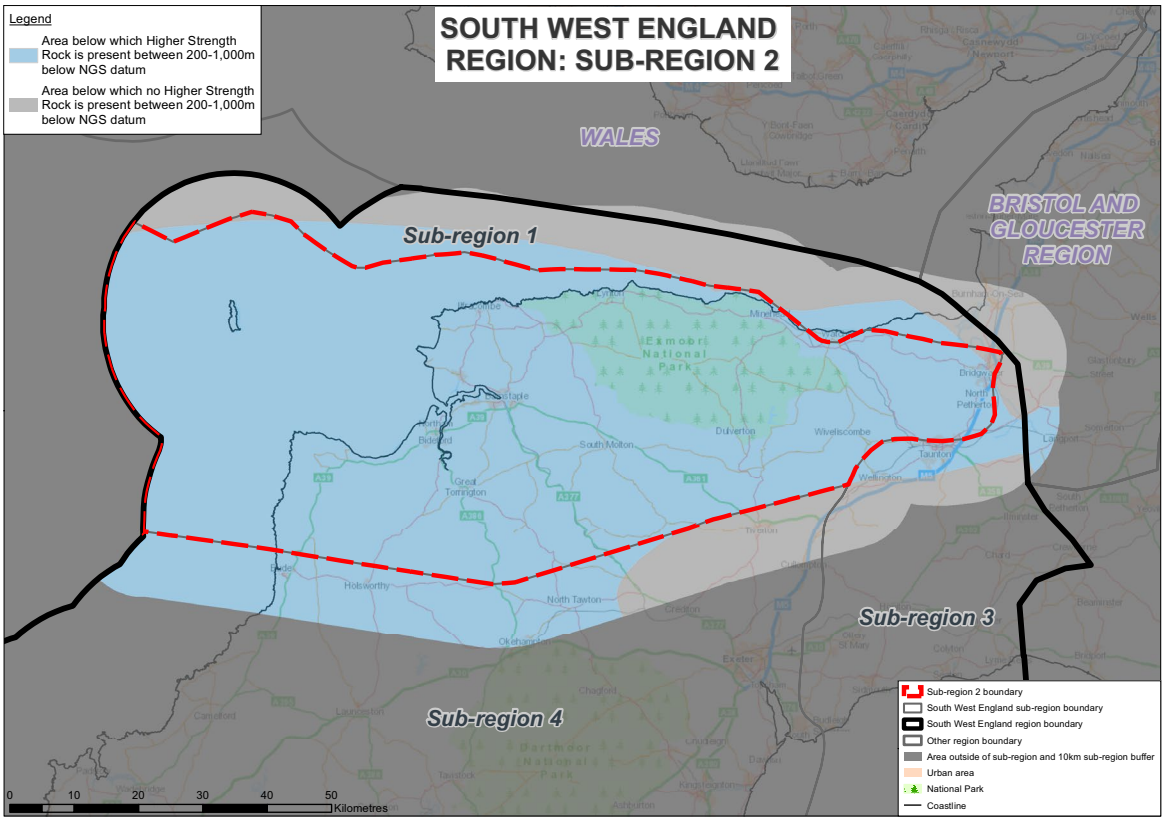


Figure 1d The areas of the South West England subregion 2 where Evaporite rock types of interest are present between 200 and 1,000 m below NGS datum.

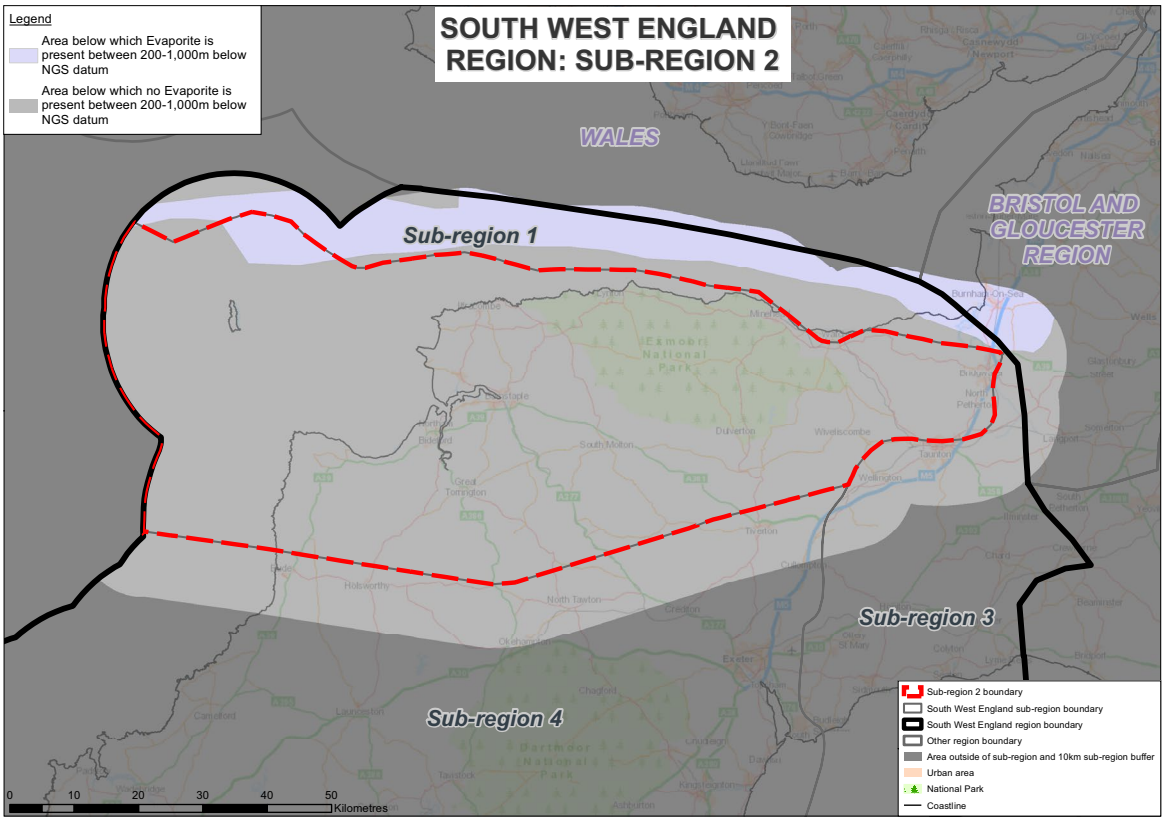


Figure 2 Location of major faults and folding in the South West England subregion 2.

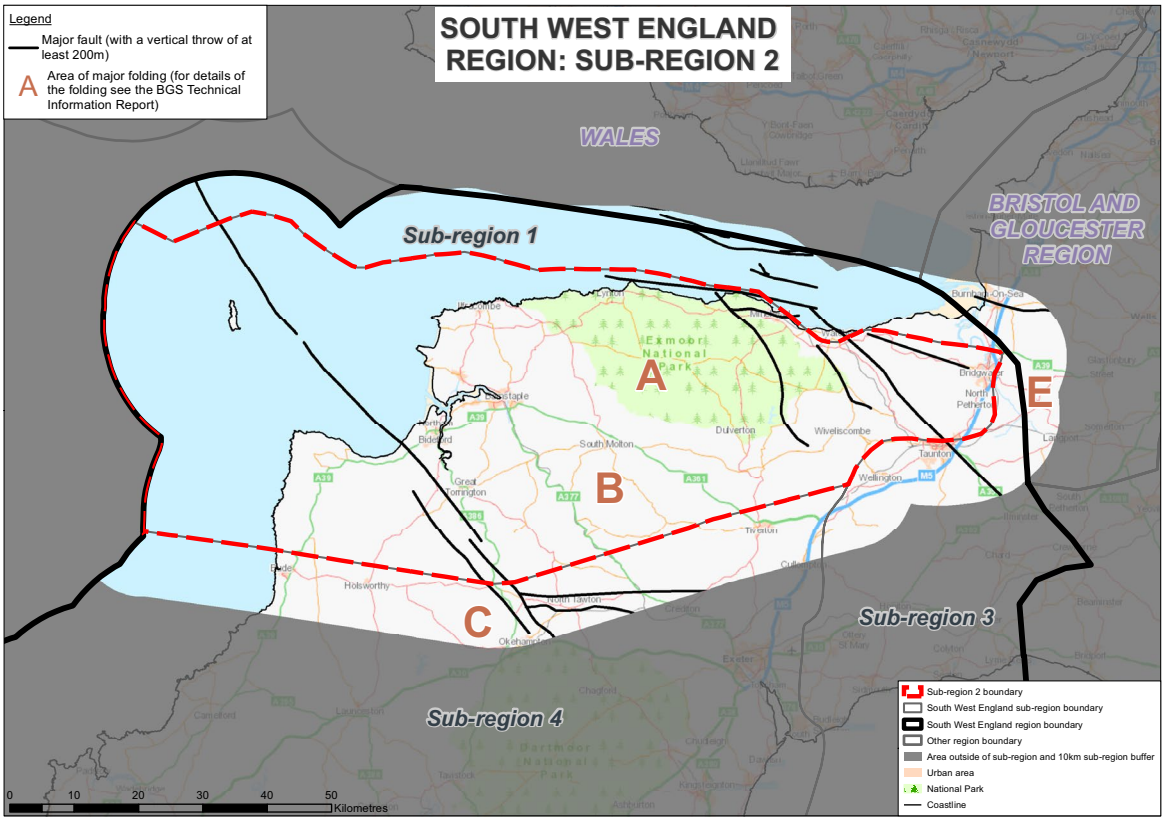


Figure 3 Areas in the South West England subregion 2 with concentrations of deep exploration boreholes.

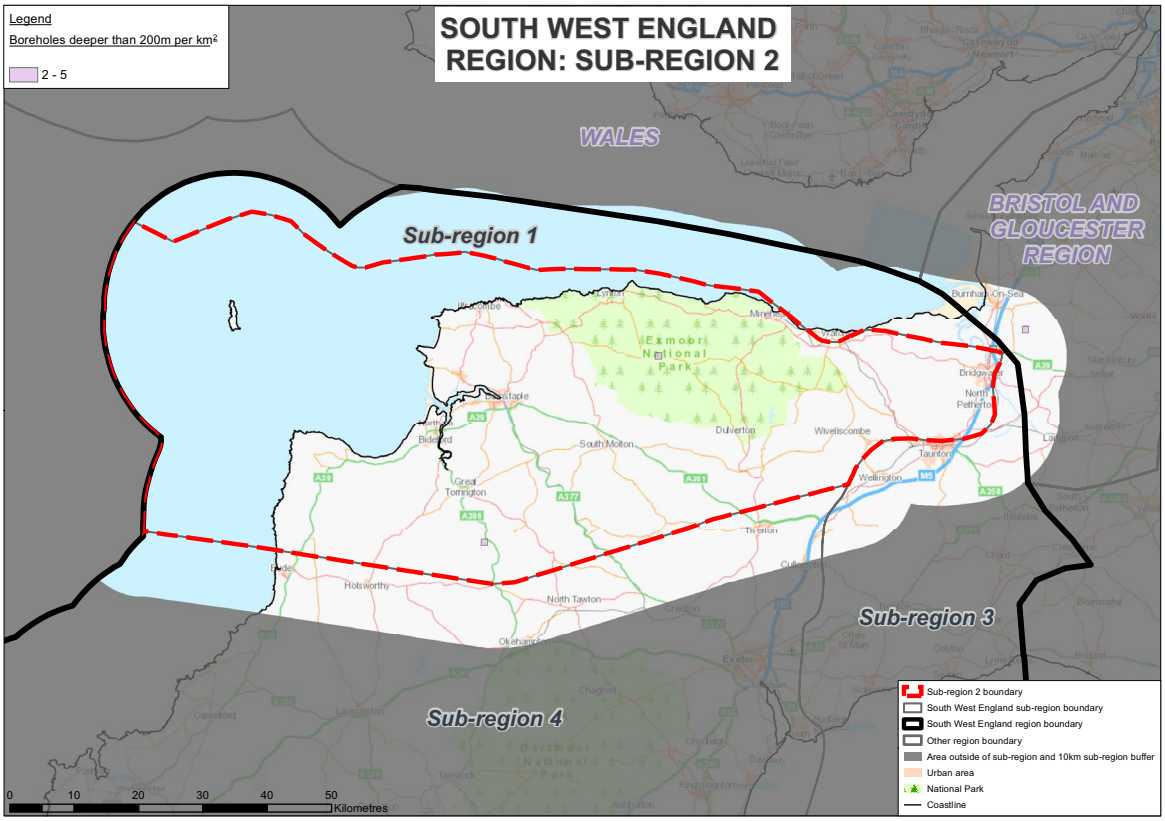


Figure 4a Areas of the South West England subregion 2 with mines present below 100m.

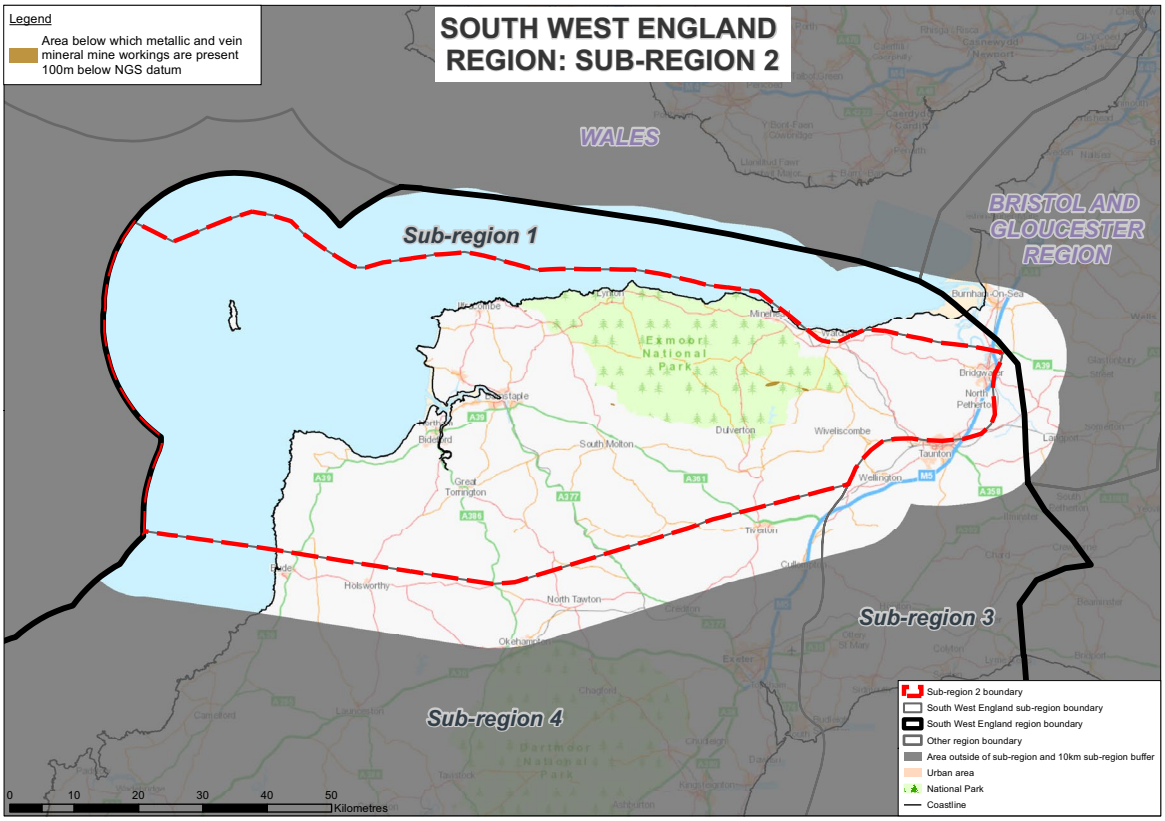
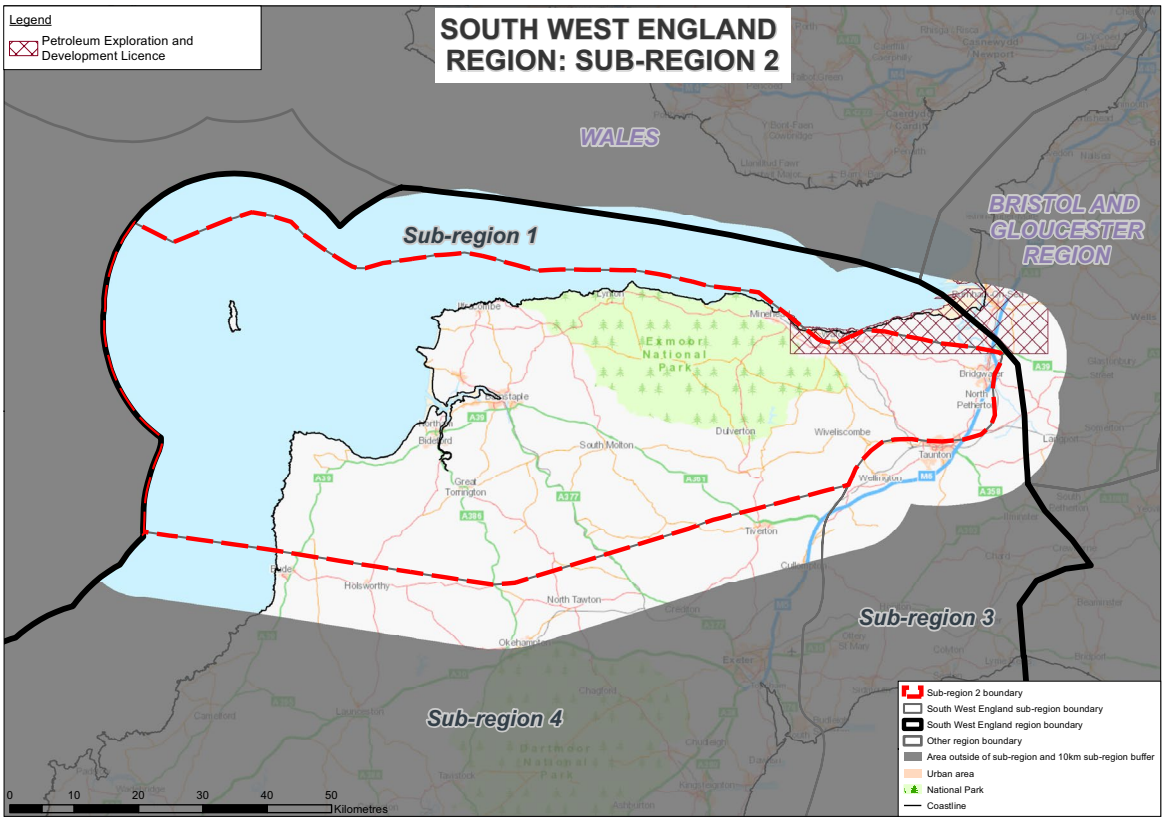


Figure 4b Areas of the South West England subregion 2 with Petroleum Exploration and Development Licences.



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.

Chert
A hard rock made of microscopic silica crystals.

Dip
The angle, or slope of a plane, such as sedimentary layering, measured relative to the horizontal.

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.

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

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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