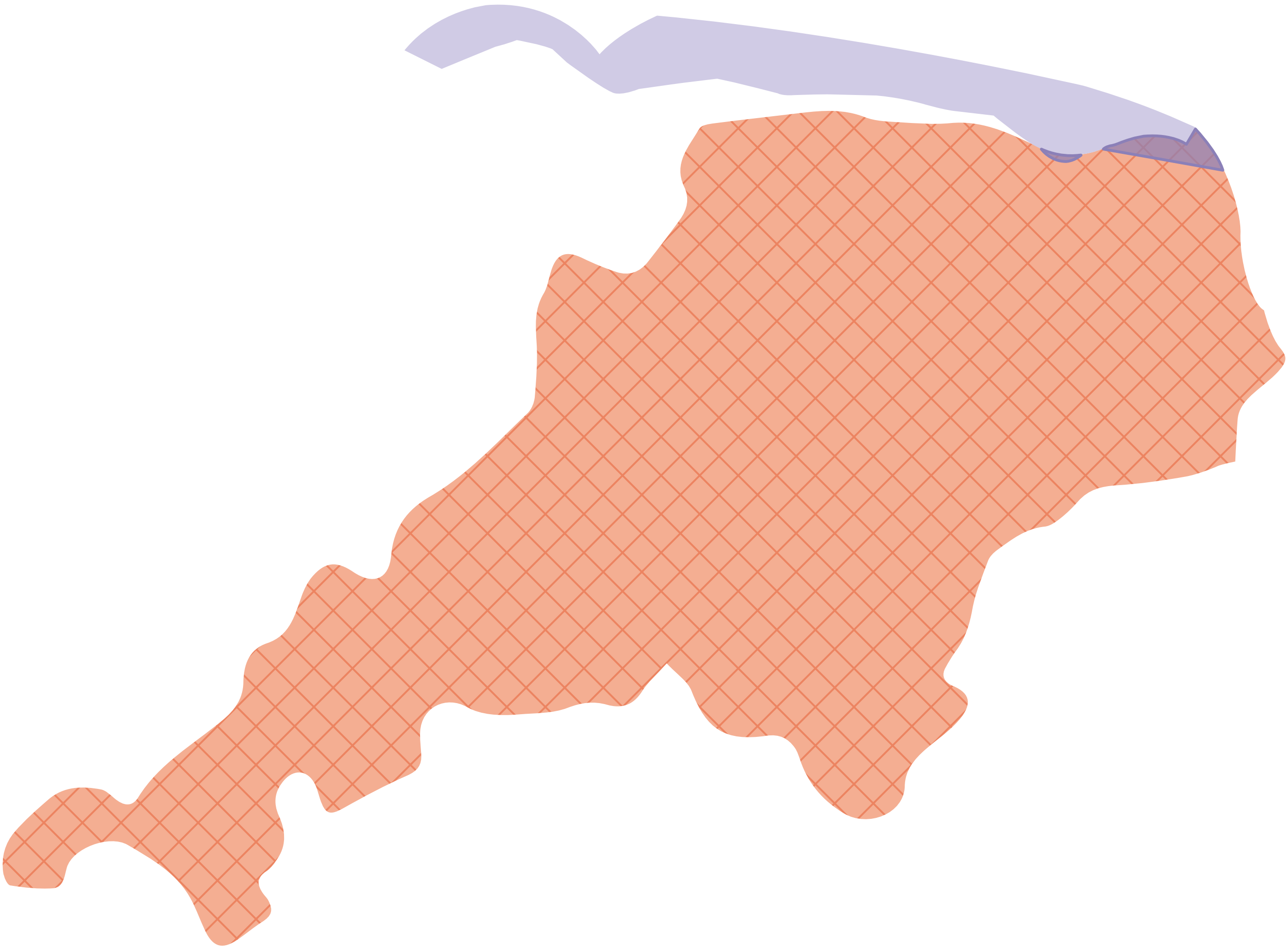
Radioactive Waste Management



South West England

SUBREGION 1

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 area which extends to 20km from the coast, rock can only be seen at the surface at a few locations including man-made excavations such as quarries or road cuttings in the onshore part of the subregion east of Kilve. 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 the northern half of the subregion and slates and similar strong rocks under some of the southern edge 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.

The onshore area to the north-west of 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.

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

This subregion is largely inshore extending to 20km from the north coast of Somerset and Devon from Bridgwater Bay, where a small part is onshore, to the north-west of Ilfracombe.

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. Younger sedimentary rocks occur in a basin extending the length of the inner Bristol Channel. They include Jurassic rocks (approx. 145 to 200 million years old) ranging from the Upper Jurassic to the Lias Group, as well as the underlying Triassic Mercia Mudstone Group (approx. 200 to 250 million years old), which are Rock Types of Interest:

- Middle and Upper Jurassic mudstones occur about 10km from the north Devon coast in a fault-bounded basin. These mudstones are likely to include several units recognised as Lower Strength Sedimentary Rocks (LSSR) in other regions, but only limited borehole information is available.
- The Jurassic Lias Group is present within the depth range of interest under most of the subregion and continues onshore in the Bristol and Gloucester region. It contains mudstones interbedded with limestones. The individual mudstone layers are unlikely to be thick enough to act as a host rock, but the Lias Group is likely to provide effective hydraulic separation between deep and shallow groundwater.
- The Mercia Mudstone Group occurs beneath the Jurassic rocks and is within the depth range of interest throughout this subregion. It is approximately 500m thick at the eastern edge of the subregion where, as well as mudstones, sandstones and evaporites comprising rock salt (halite) layers. The rock salt occurrences are the western extension of an area of salt in Somerset and are a potential Evaporite host rock. The extent of the rock salt is not well known but it appears to become thinner to the west and so is only likely to be a potential host rock in the eastern part of the subregion. The Mercia Mudstone Group is dominated by dolomitic mudstones and siltstones, with gypsum also present in veins and nodules. The mudstone layers are known to act as a barrier to groundwater movement and have the potential to act as LSSR host rocks where they are sufficiently thick.

In addition to the rocks described above, the BGS has identified clay-rich Oligocene rocks (approx. 25 to 35 million years old) off the coast, some 20 km northwest of Barnstaple, within a fault-bounded basin some 30 km by 20 km in extent. Thicknesses are unknown and hence it is not known if these rocks extend into the depth range of interest, between 200 and 1,000 m below NGS datum.

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.

Devonian and Carboniferous basement rocks are present within the depth range of interest below the LSSR layers along the southern edge of the subregion. These rocks have been folded and metamorphosed so that the mudrocks have become slaty and are therefore potential Higher Strength Rock (HSR) hosts. They are discussed in more detail in subregion 2 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

The younger sedimentary rocks in this subregion occur as gently-dipping layers with a small number of major faults bounding the sedimentary basins (Figure 2); in places the sedimentary layers are steeply tilted and intensively folded related to movement on small faults. 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 basement rocks are likely to be faulted, fractured and folded where they are present in the south of the subregion and this may impact groundwater movement and complicate the search for a volume of rock with sufficiently uniform properties within them.

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. The Sherwood Sandstone Group and 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 present 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 does act as an aquifer onshore where it occurs at or near the surface as an intensely folded and faulted unit in the Quantock Hills at the eastern end of the subregion.

It is likely that the Lias and Mercia Mudstone Group LSSR layers act as barriers to groundwater movement from depth towards the seabed, even where they are not thick enough to host a GDF. Figure 3 shows a small area (approximately 1km^2) to the north of Bridgwater where the presence of several deep exploration boreholes may influence the connectivity between shallow and deep groundwater and would need to be considered during the siting process. 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.

Resources

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

Petroleum Exploration and Development Licences are currently held for the onshore part of this subregion to the north-west of Bridgwater (Figure 4). 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 1 where any of the 3 Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

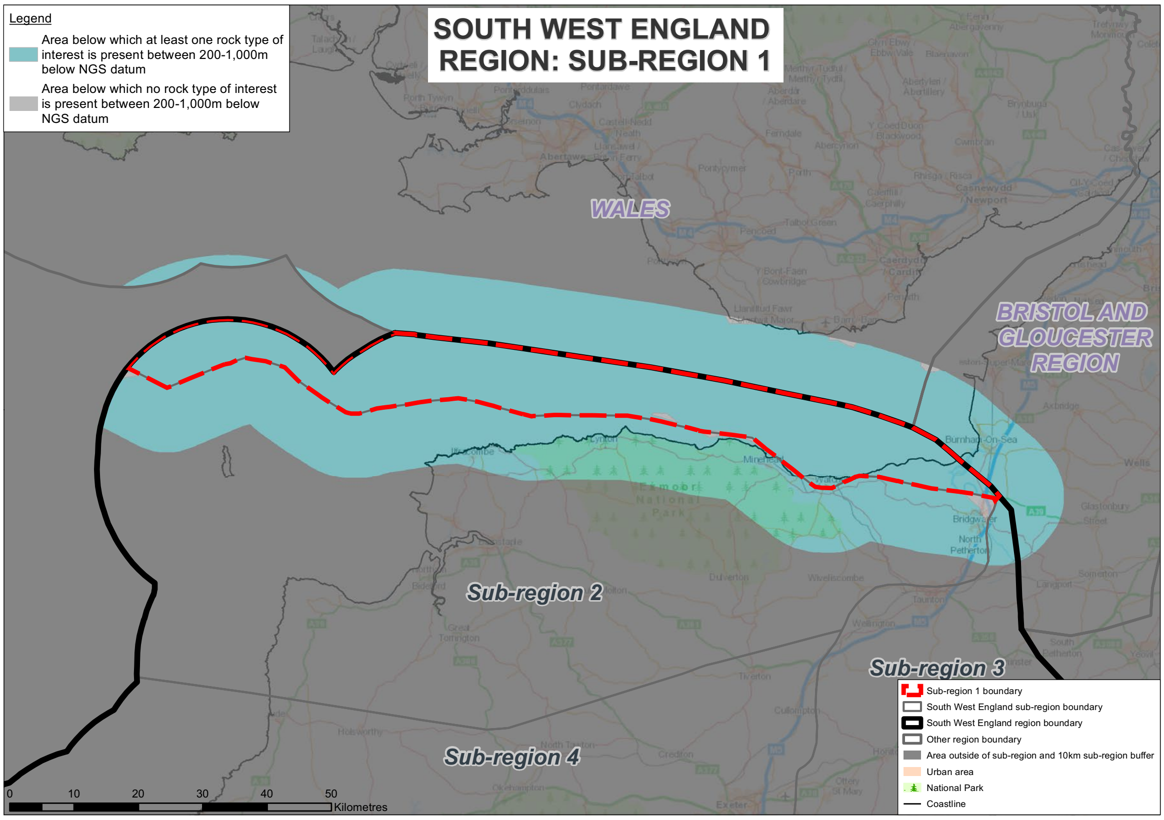


Figure 1b The areas of the South West England subregion 1 where Lower Strength Sedimentary Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

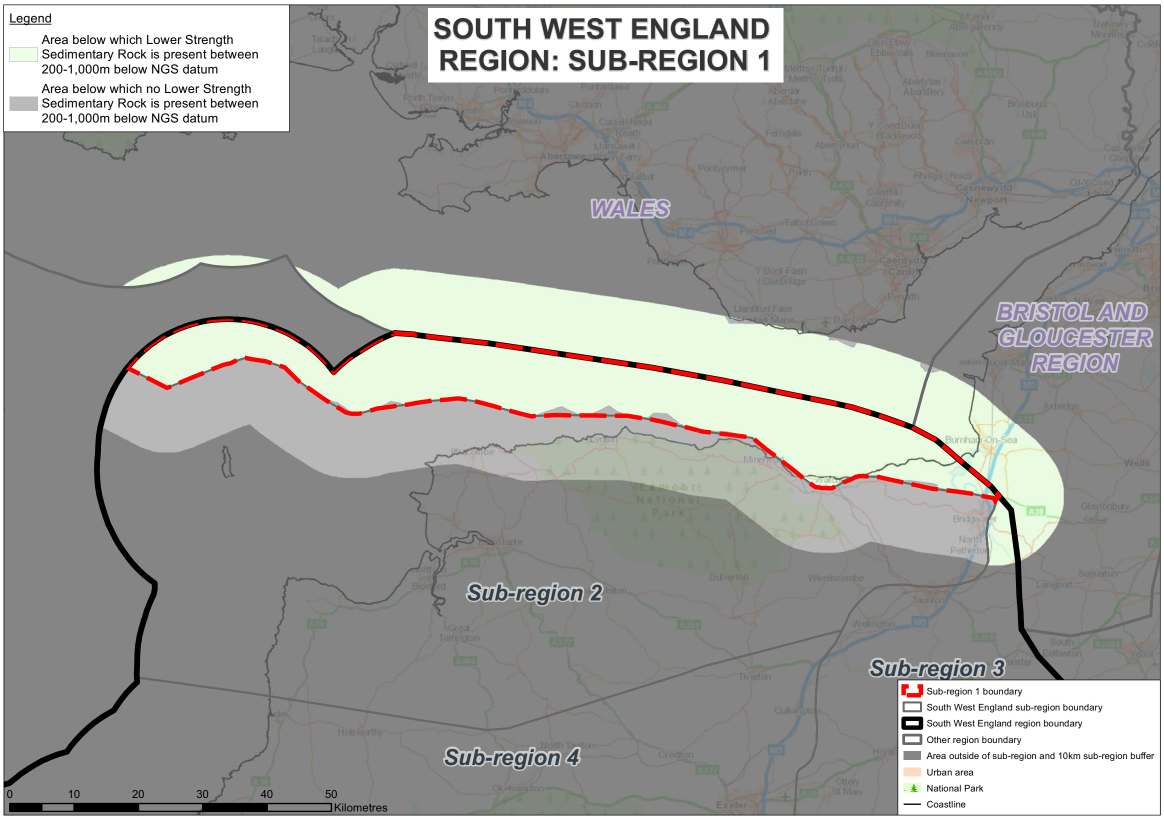


Figure 1c The areas of the South West England subregion 1 where Higher Strength Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

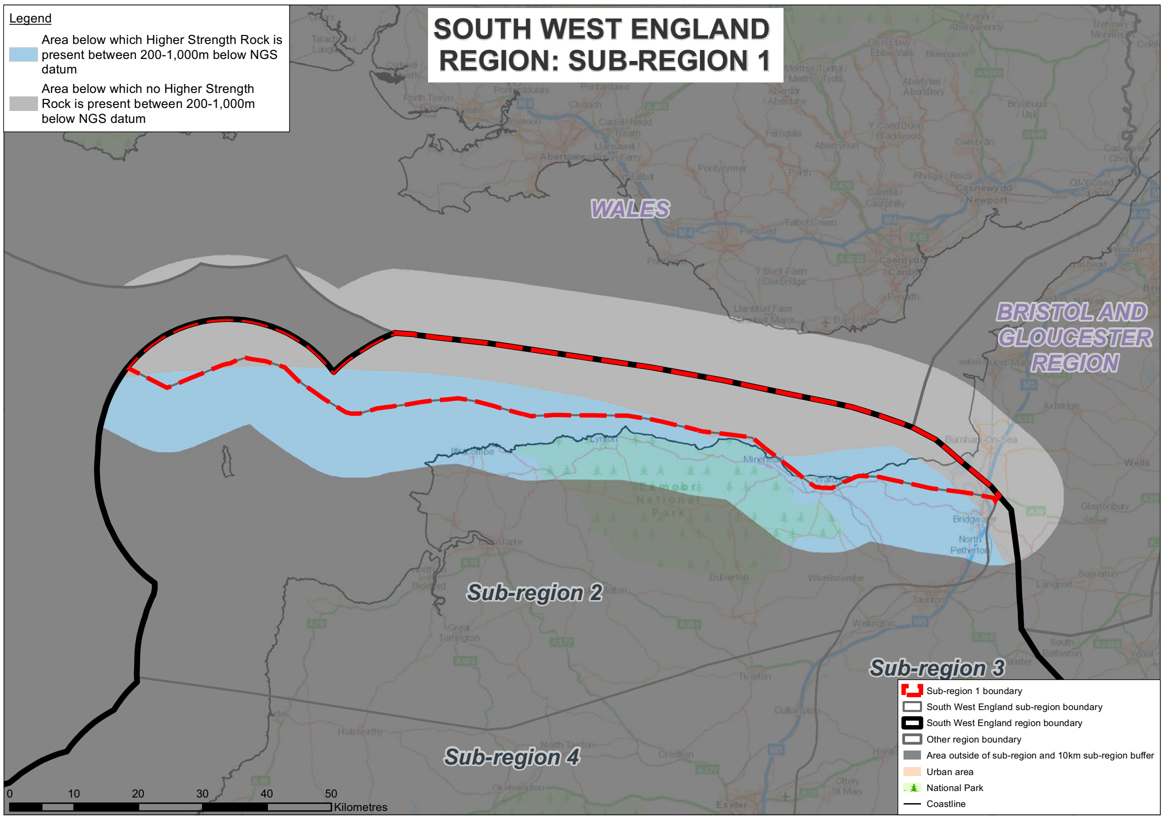


Figure 1d The areas of the South West England subregion 1 where Evaporite Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

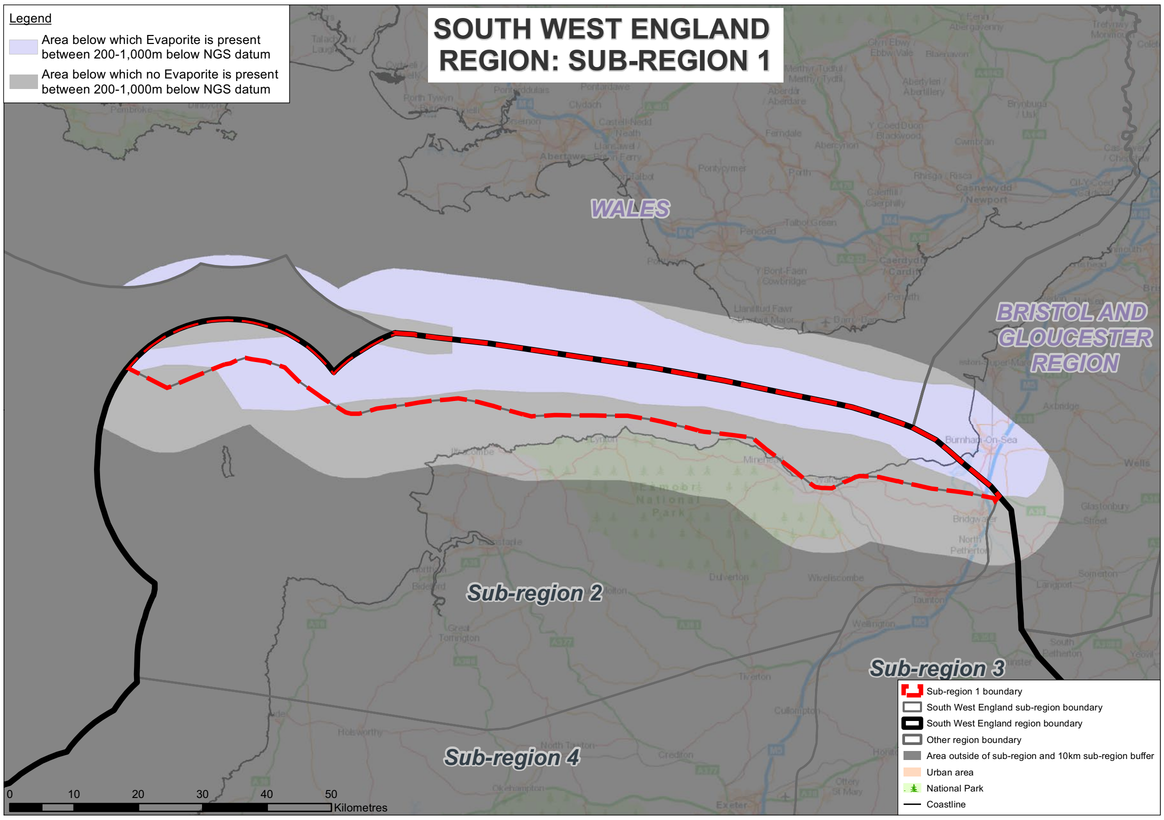


Figure 2 Location of major faults in South West England subregion 1.

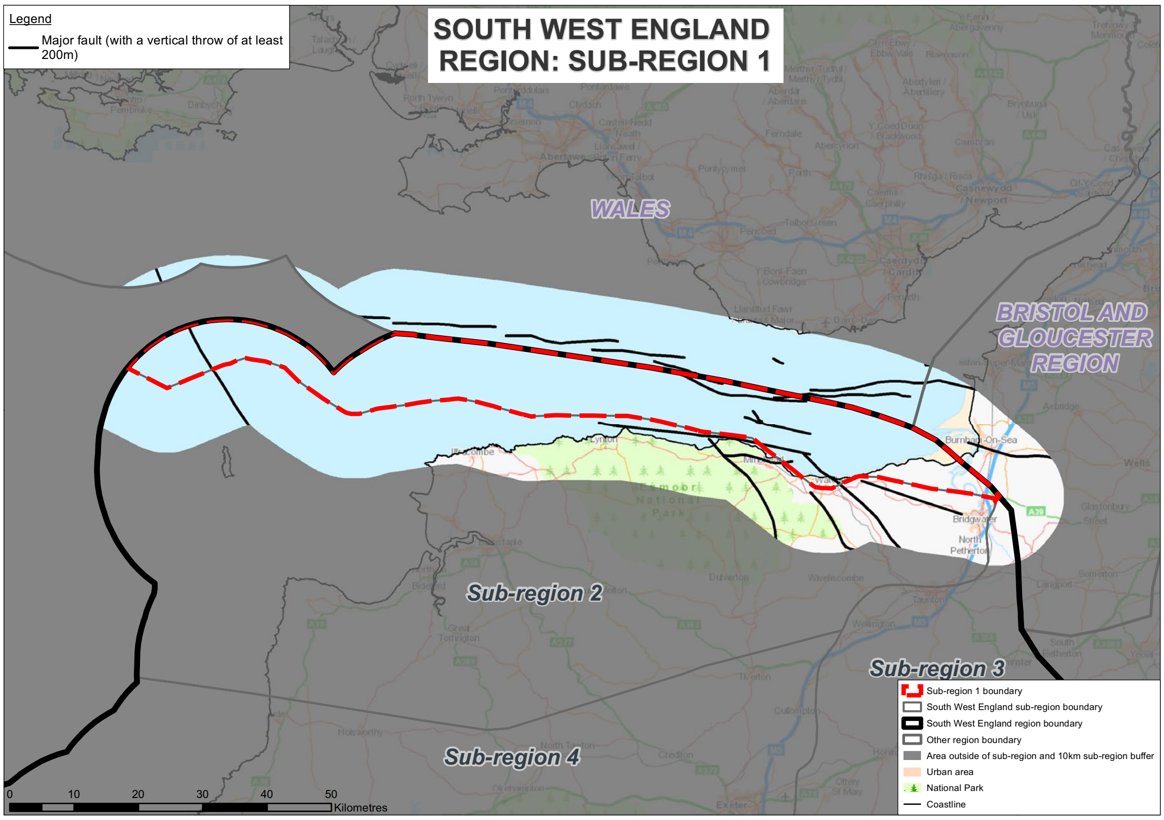


Figure 3 Areas in South West England subregion 1 with concentrations of deep exploration boreholes.

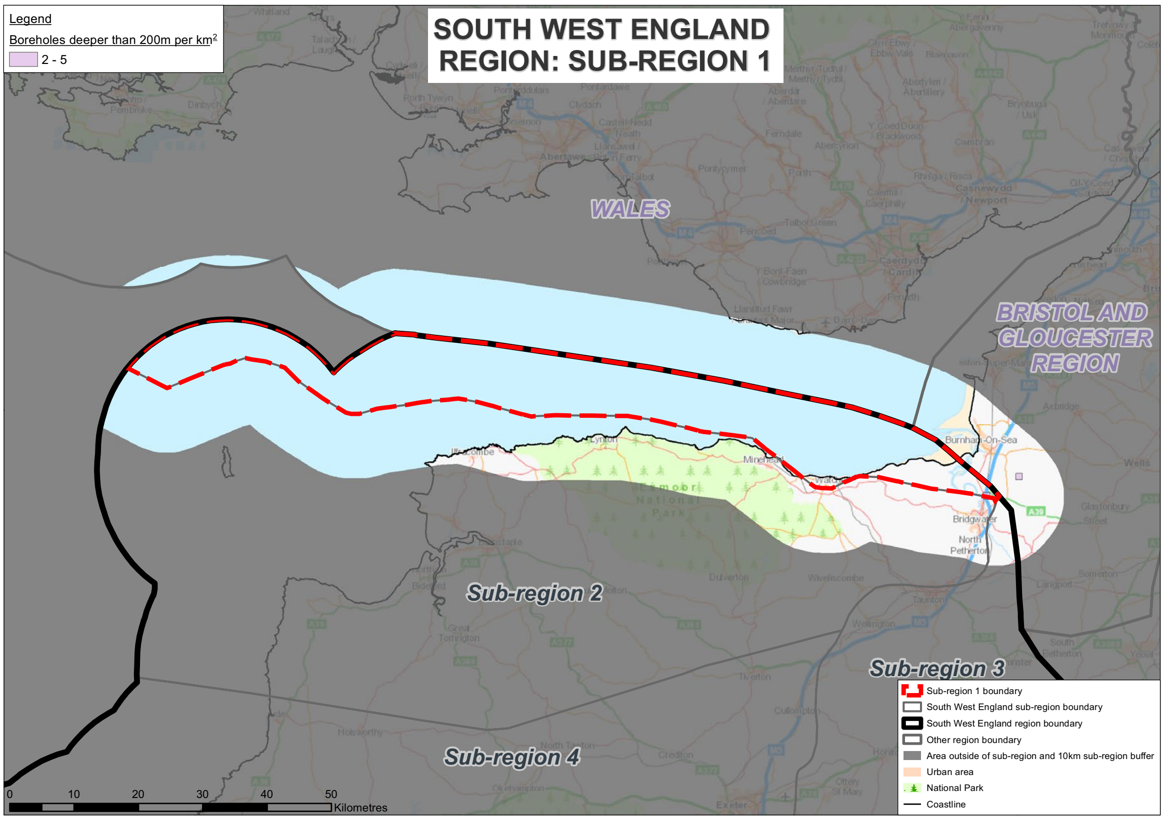
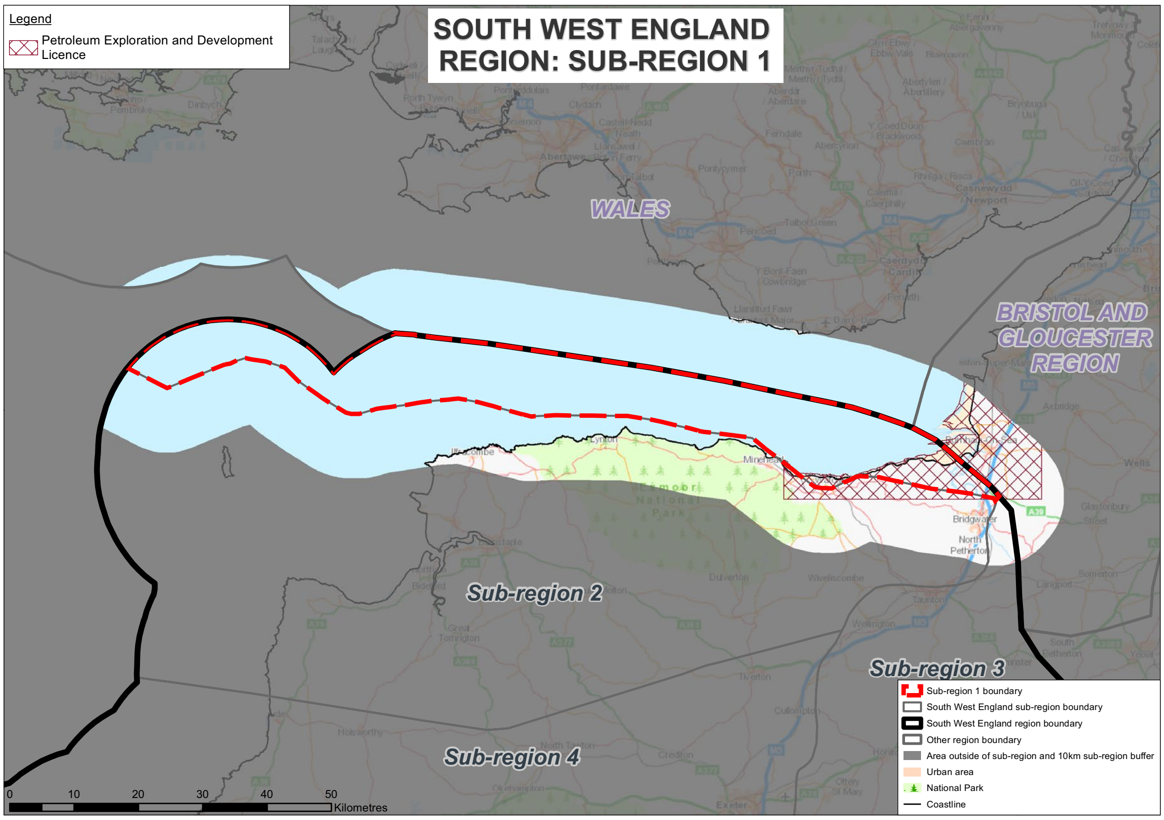


Figure 4 Areas of the South West England subregion 1 with Petroleum Exploration and Development Licences.



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.

Evaporite
The generic term for rock created by the evaporation of water from a salt-bearing solution, such as seawater, to form a solid crystalline structure. Gypsum, anhydrite and halite are all types of evaporite.

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

Fault-bounded basin
A depression formed at the surface of the earth's crust which is located on the downthrown side of a fault. These depressions provide space for sequences of sedimentary rocks to accumulate.

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

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'.

Metamorphosed
A rock that has undergone change due to the action of temperature and pressure.

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.

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.

Vein
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.

Radioactive Waste Management

Building 587
Curie Avenue
Harwell Oxford
Didcot OX11 0RH

T 03000 660100
www.gov.uk/rwm