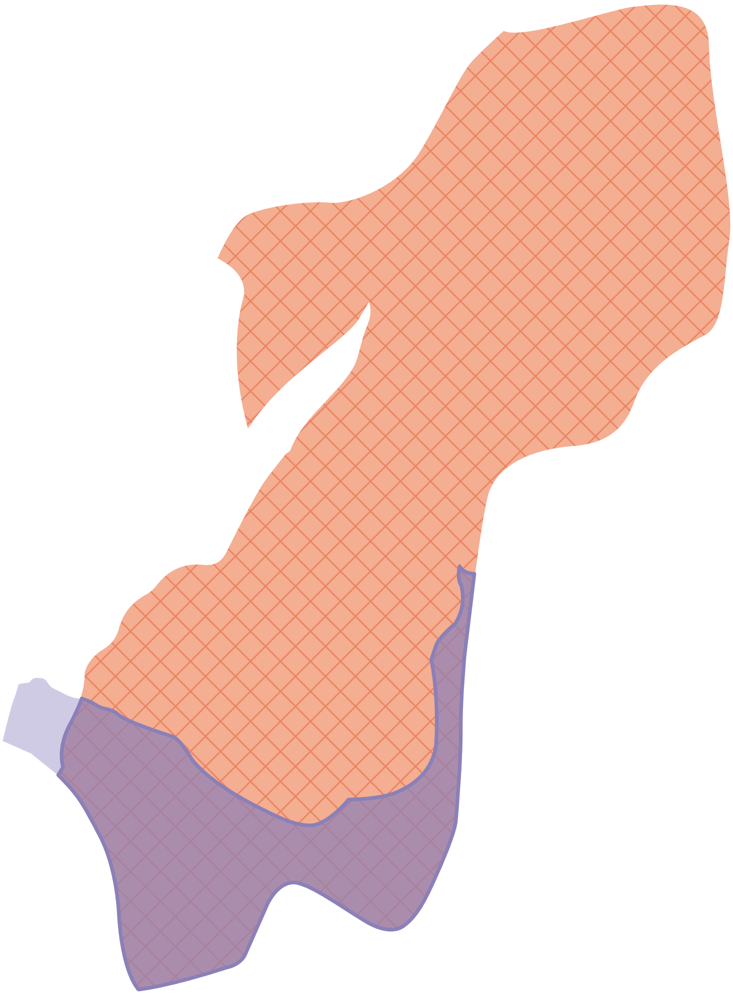
Radioactive Waste Management



Bristol and Gloucester

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 this subregion at rocky outcrops such as Glastonbury Tor and in man-made excavations such as quarries or road cuttings. However, some deep boreholes and geophysical investigations give us an understanding of the rocks present and their distribution.

There are clay-rich rock layers under the whole subregion in which we may be able to site a GDF. There are also layers of rock salt, around Burnham-on-Sea and extending under the Bristol Channel, and slates and similar strong rocks, around Langport and south of Frome, 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.

The area around Highbridge and Burnham-on-Sea 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

The Bristol and Gloucester subregion 2 extends from near Corsham in the north, south to Wincanton and then west to Glastonbury and Burnham-on-Sea.

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 Lower Strength Sedimentary Rocks (LSSR) and Evaporite rocks of interest in this subregion are part of the younger sedimentary cover:

- In the eastern part of the subregion, the Upper Jurassic Kellaways and Oxford Clay Formations (approx. 145 to 165 million years old) attain a combined thickness of 150m and are dominated by mudstone with thin siltstone and limestone layers. Their considerable thickness means they have the potential to host a GDF as well as providing hydraulic separation between deep and shallow groundwater. Below these formations, the Frome Clay Formation, a calcareous mudstone with thin limestones up to 70m thick, is also a potential LSSR host rock.
- The Lower Jurassic Lias Group (approx. 175 to 200 million years old) in this subregion is dominated by mudstones in its lower half with increasing numbers of sandstone and limestone beds in the upper half. These rocks are very thin in the Mendips area and become progressively thicker toward the south-west and south-east. Even in the thicker, more mudstone-rich Lias Group successions it is unlikely that individual mudstones are thick enough to act as a host rock, but its low overall permeability is likely to provide hydraulic separation between deep and shallow groundwater.
- The Triassic Mercia Mudstone Group (approx. 200 to 250 million years old) occurs beneath the Jurassic rocks and within the depth range of interest over much of this subregion. It is dominated by mudstones and thin siltstones, with some sandstone beds. The thick mudstone units are known to act as a barrier to groundwater movement and may have the potential as LSSR host rocks, particularly since they are overlain by Jurassic mudstones.

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.

There is one sequence of evaporite rock layers containing a rock salt (halite) layer up to 30m thick in the western part of this subregion, and extending beneath the Bristol Channel. It is not known whether this rock salt layer is sufficiently thick to be a potential host rock but it would present a significant barrier to groundwater movement between deep and shallow aquifers.

In the southernmost part of the subregion, Mercia Mudstone Group is underlain by Devonian Upper and Lower Old Red Sandstone Group rocks (approx. 360 to 420 million years old) . These rocks are deformed and metamorphosed such that the mudrock layers within them have become slaty and so have potential as a Higher Strength Rock (HSR) host for a GDF.

A summary of the geological attributes of the Bristol and Gloucester 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 only a small number of major faults in this subregionand one area of major folding (Figure 2). The folding is associated with an anticlinal structure in the south-west of the subregion. 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, although there is information on groundwater in aquifers above 200m. There are several principal aquifers within 400m of the surface in this subregion including the Great and Inferior Oolites. These limestone aquifers are used for public water supply in the east of the subregion in the Cotswold Hills. The Sherwood Sandstone Group and Carboniferous Limestone aquifer are principal aquifers in other regions where they occur at shallow depths. In this subregion they occur at depths greater than 400m and brine was encountered in the Sherwood Sandstone Group at 1,105m depth in a borehole. Groundwater from depths greater than 400m is unlikely to be suitable as drinking water anywhere in the UK[2].

Where information is available for other regions, it is clear that the Mercia Mudstone Group and Lias Group provide hydraulic separation between aquifers and between deep and shallow groundwater.

In one small area 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.

Resources

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

Petroleum Exploration and Development Licences are currently held for a largely onshore part of this subregion around Highbridge and Burnham-on-Sea (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.

[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.

Figure 1a The areas of the Bristol and Gloucester subregion 2 where any of the 3 Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

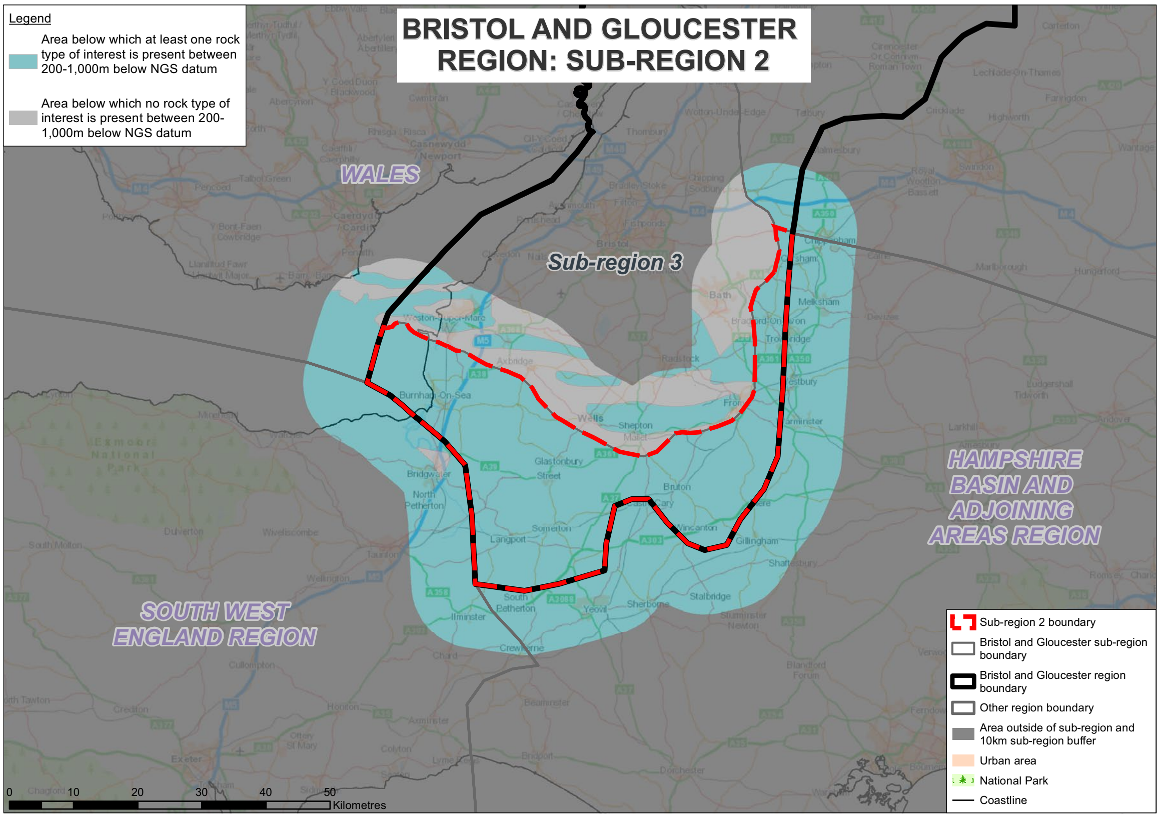


Figure 1b The areas of the Bristol and Gloucester subregion 2 where Lower Strength Sedimentary Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

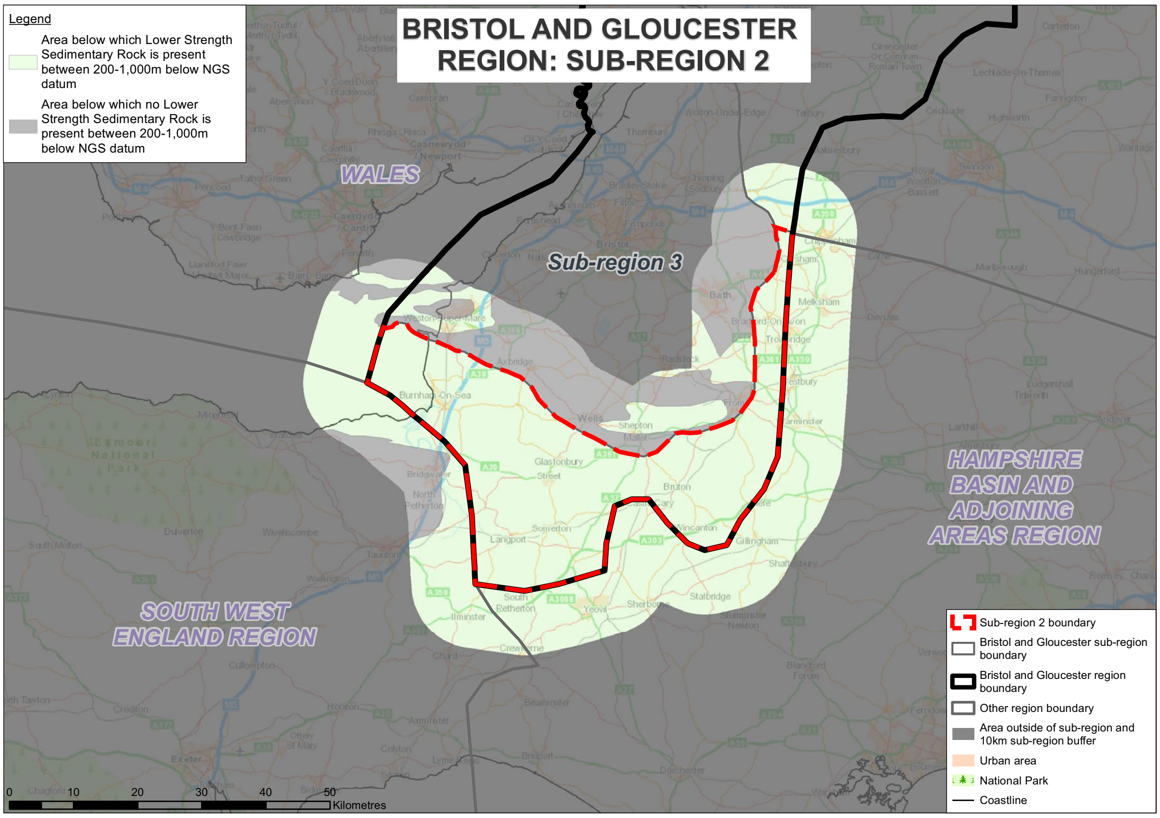


Figure 1c The areas of the Bristol and Gloucester subregion 2 where Higher Strength Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

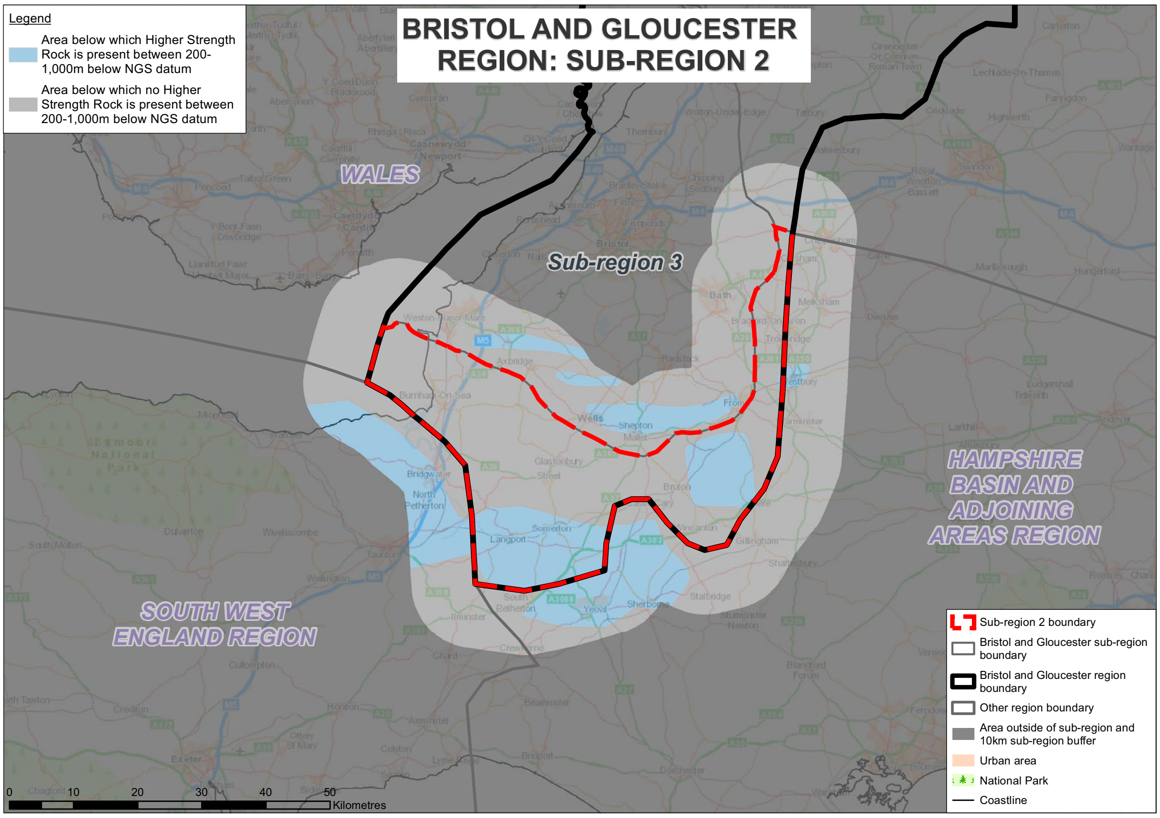


Figure 1d The areas of the Bristol and Gloucester subregion 2 where Evaporite Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

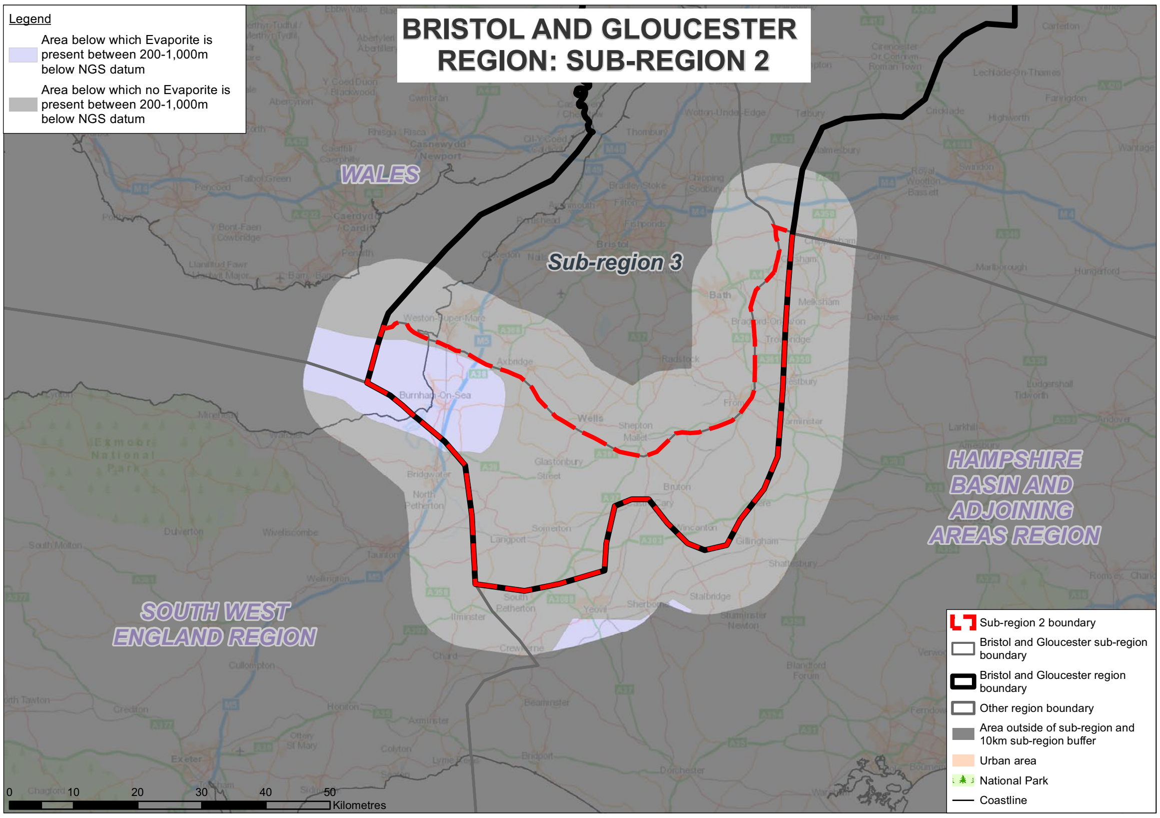


Figure 2 Location of major faults and folding in the Bristol and Gloucester subregion 2.

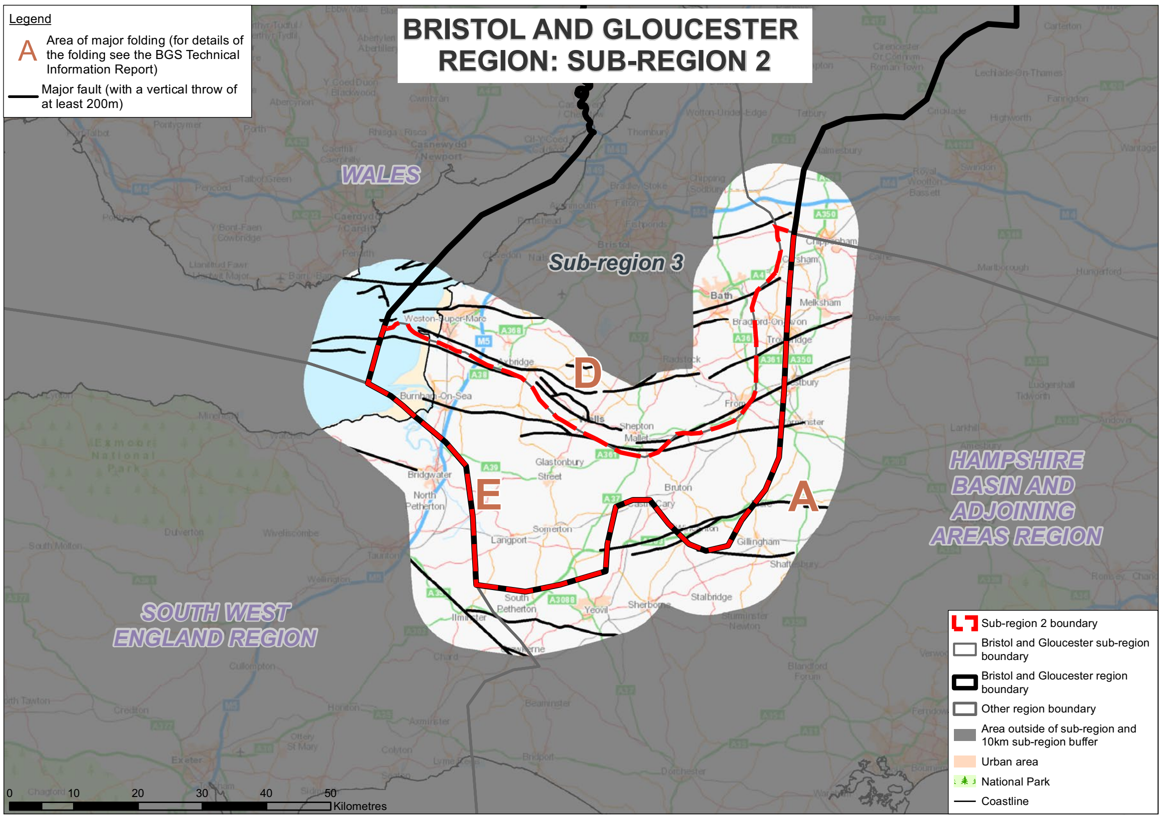


Figure 3 Areas in the Bristol and Gloucester subregion 2 with concentrations of deep exploration boreholes.

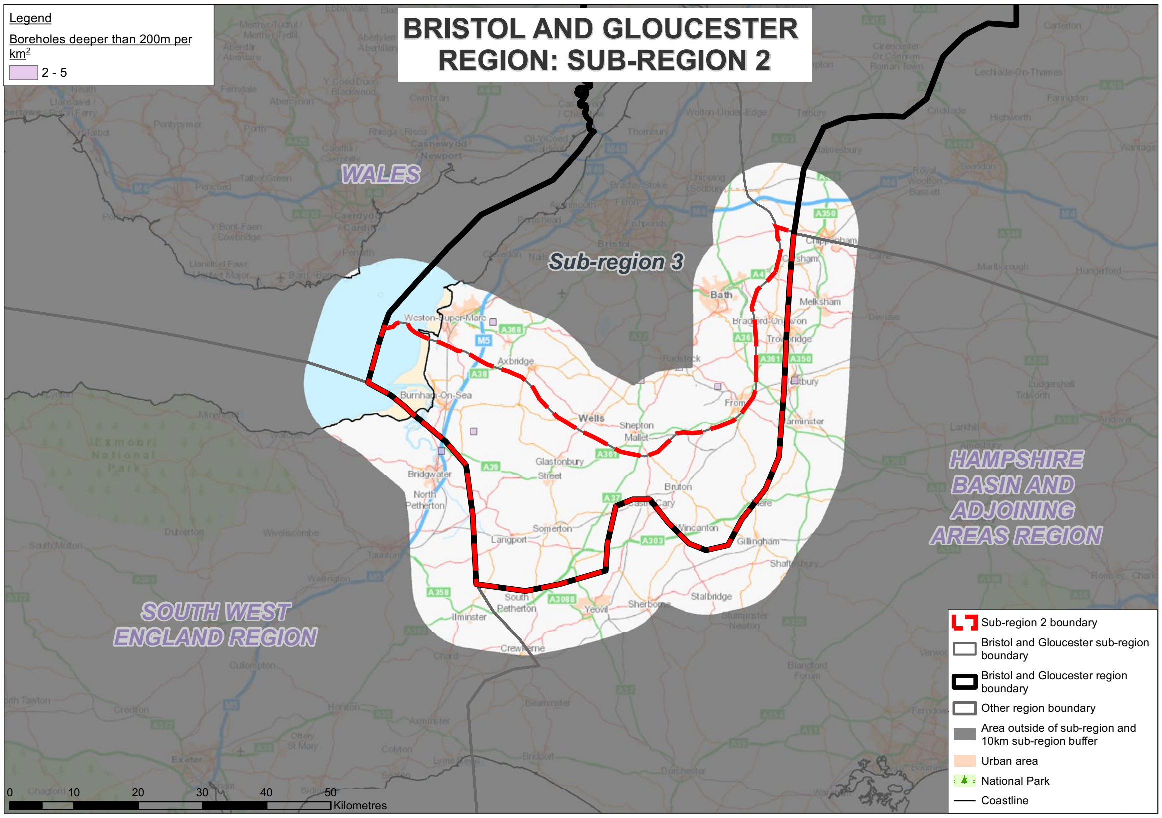
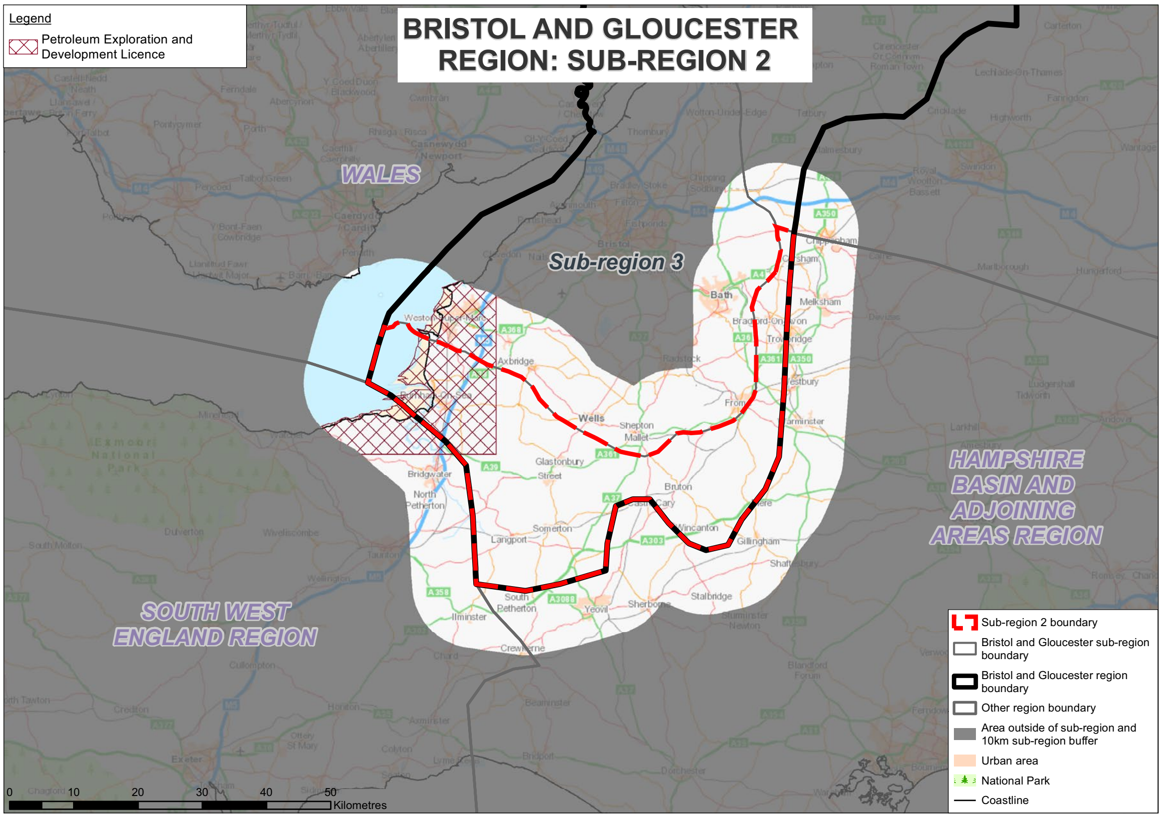


Figure 4 Areas of the Bristol and Gloucester subregion 2 with Petroleum Exploration and Development Licences.



Glossary

Anticline
A type of fold where the rock layers are buckled to form a dome-shaped structure.

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.

Brines
Water that is either saturated with dissolved salts, or contains a large amount of dissolved salt. An example of a brine is seawater

Calcareous
A rock or sediment that contains the mineral calcium carbonate.

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.

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.

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

Radioactive Waste Management

Building 587
Curie Avenue
Harwell Oxford
Didcot OX11 0RH

T 03000 660100
www.gov.uk/rwm