

**Bristol and
Gloucester**
SUBREGION 3



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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 subregion, but the potential rock may not be present in suitably shaped or sized volumes.

Rock can be seen at the surface in some of the subregion such as the Forest of Dean, the Avon and Cheddar Gorges and the Mendips 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 south of Bristol, around Weston-super-Mare and between Wells and Frome, in which we may be able to site a GDF. There are also [volcanic lavas and similar strong rocks](#) between Wells and Frome and to the north of Frome, in which we may be able to site a GDF. These rocks may not be present in suitably shaped or sized volumes and we would need to do more work to find out whether they 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 for coal [resources](#) to depths below 100m, in the Forest of Dean and around Bristol and Midsomer Norton and iron ore to depths below 100m, also in the Forest of Dean. 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](#).

Parts of the Forest of Dean are also [Coal Authority Licence Areas](#) allowing companies to explore for coal. It is not known whether coal in these licence areas will be exploited. RWM will continue to monitor how this exploration programme progresses.

The area around Weston-super-Mare 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 also continue to monitor how this exploration programme progresses.

There are [thermal springs](#) in Bristol and Bath which indicate that groundwater is moving rapidly from depth to the surface in these areas. This would need to be considered in the siting of a GDF in this subregion.



Introduction

Bristol and Gloucester subregion 3 extends from the Forest of Dean in the north-west to Weston-super-Mare and Shepton Mallet in the south, with an eastern boundary running north from Frome to Dursley.

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 geology of the subregion is dominated by **younger** and **older sedimentary rocks**. There are no Rock Types of Interest over much of the subregion and even where they are present they occur as relatively small volumes broken up by faulting. There are 2 main Rock Types of Interest:

- The Carboniferous age (approx. 300 to 360 million years old) Warwickshire Group rocks are dominated by mudstones and siltstones with low overall **permeability**. However in this subregion the Warwickshire Group also contains coal seams that were mined in the Bristol and Somerset and Forest of Dean coalfields. Whilst the Warwickshire Group probably presents an effective **barrier to upward groundwater flow**, the variable mechanical strength and thin-bedded nature of coal-bearing successions means that it is unlikely to be suitable as a **Lower Strength Sedimentary Rock (LSSR)** host for a GDF.
- Silurian volcanic rocks (approx. 420 to 485 million years old) occur beneath much of the subregion and comprise **lava flows** with interbedded **sediments**. Despite the potential of this rock type as **Higher Strength Rock (HSR)** hosts, these Silurian **lavas** only occur within the depth range of interest in a few small isolated blocks (**Figure 1c**) and are often steeply dipping.

A summary of the geology 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

The southern half of the subregion is characterised by major **fault** zones, in some places associated with local **folding** of the rock layers (**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 GDF¹. The complex nature of the faulting and folding is likely to complicate the search for a volume of rock with sufficiently uniform properties in this subregion.

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.



Groundwater

The Carboniferous Limestone aquifer is a **principal aquifer** which dominates groundwater flow within 400m of the surface in this subregion. This **aquifer** has well-developed **karst**, where concentration of mildly acidic groundwater has enlarged **fractures** by dissolution to form a connected network of major fissures and caves. Evidence for deep circulation of groundwater through these karst systems is provided by well-known occurrences of **thermal springs**, for example in Bristol and Bath (Figure 3). They indicate rapid return to the surface of warm, deep-sourced groundwater and would not therefore provide ideal geological conditions to host a GDF. There are no extensive **LSSR** layers in this subregion to provide **hydraulic separation** between deep and shallow groundwater.

There are a number of locations in this subregion where concentrations of **deep exploration boreholes** may influence the connectivity between shallow and deep groundwater which would need to be considered during the siting process (Figure 4).

Resources

Coal has been mined extensively below 100m in the Bristol and Somerset Coalfield and the Forest of Dean Coalfield with iron ore mining in the Forest of Dean also extending below 100m (Figure 5a). Iron ore was also mined in the Forest of Dean, with a few mines extending below 100m in the east (Figure 3). 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.

There are also **Coal Authority Licence Areas** in the Forest of Dean (Figure 5a) and **Petroleum Exploration and Development Licences** (Figure 5b) allowing companies to explore for coal and hydrocarbons. It is not known whether coal, oil or gas in these licence areas will be exploited, but they would need to be considered during the siting process.

The full area of iron ore mining in the Forest of Dean and metal mining in the Mendips is shown on Figure 6 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 1a The areas of the Bristol and Gloucester subregion 3 where any of the 3 Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

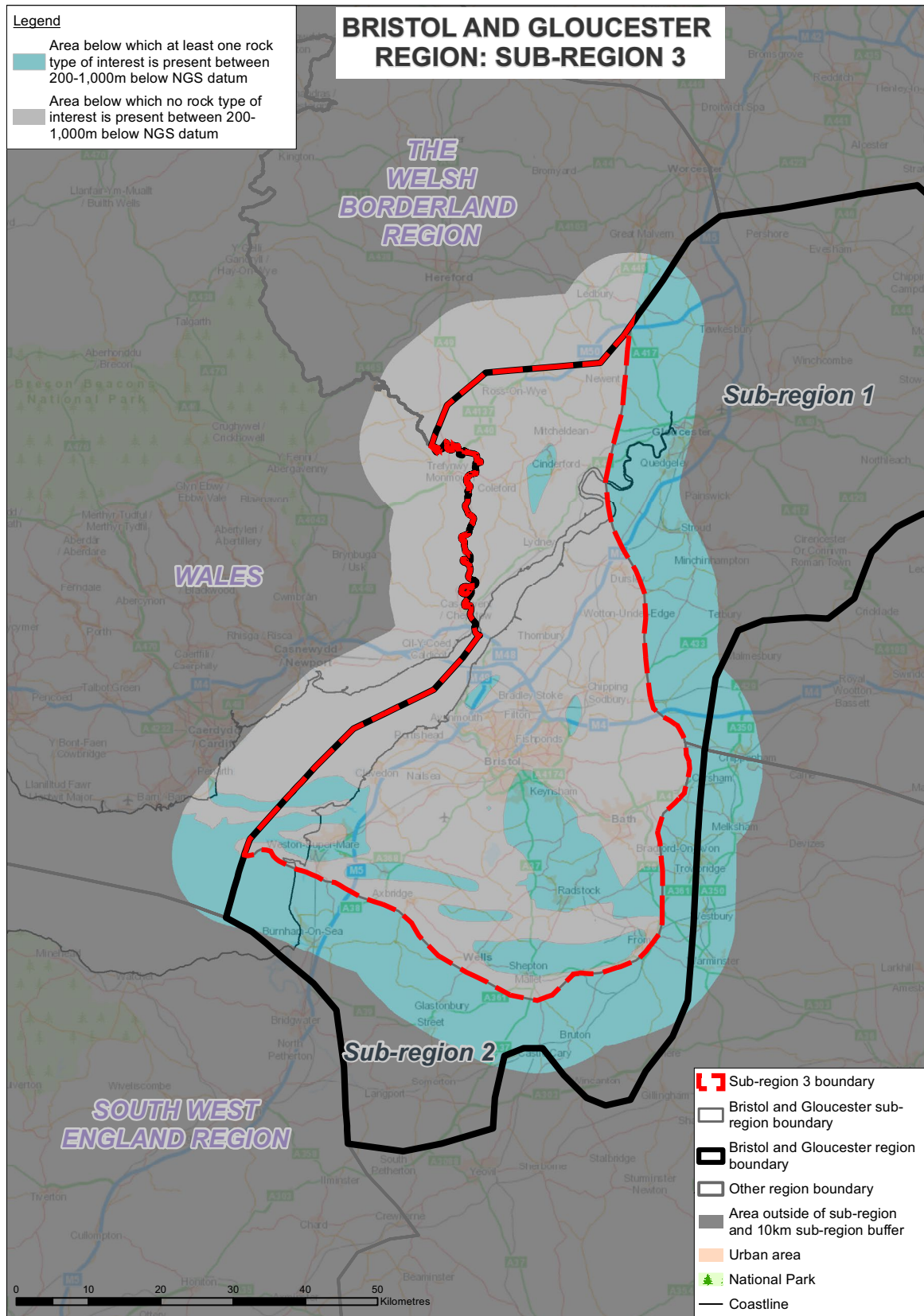




Figure 1b The areas of the Bristol and Gloucester subregion 3 where Lower Strength Sedimentary Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

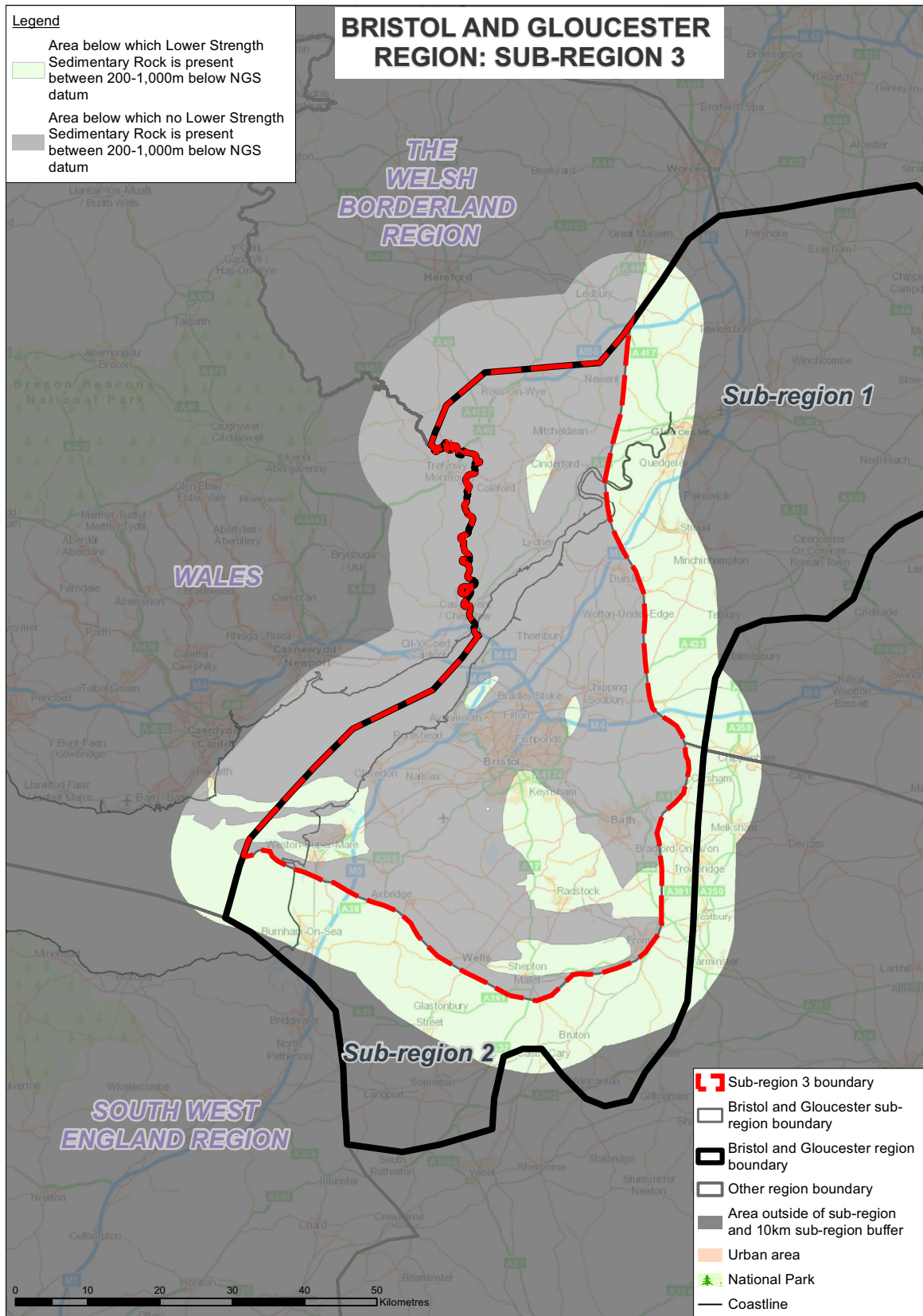




Figure 1c The areas of the Bristol and Gloucester subregion 3 where Higher Strength Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

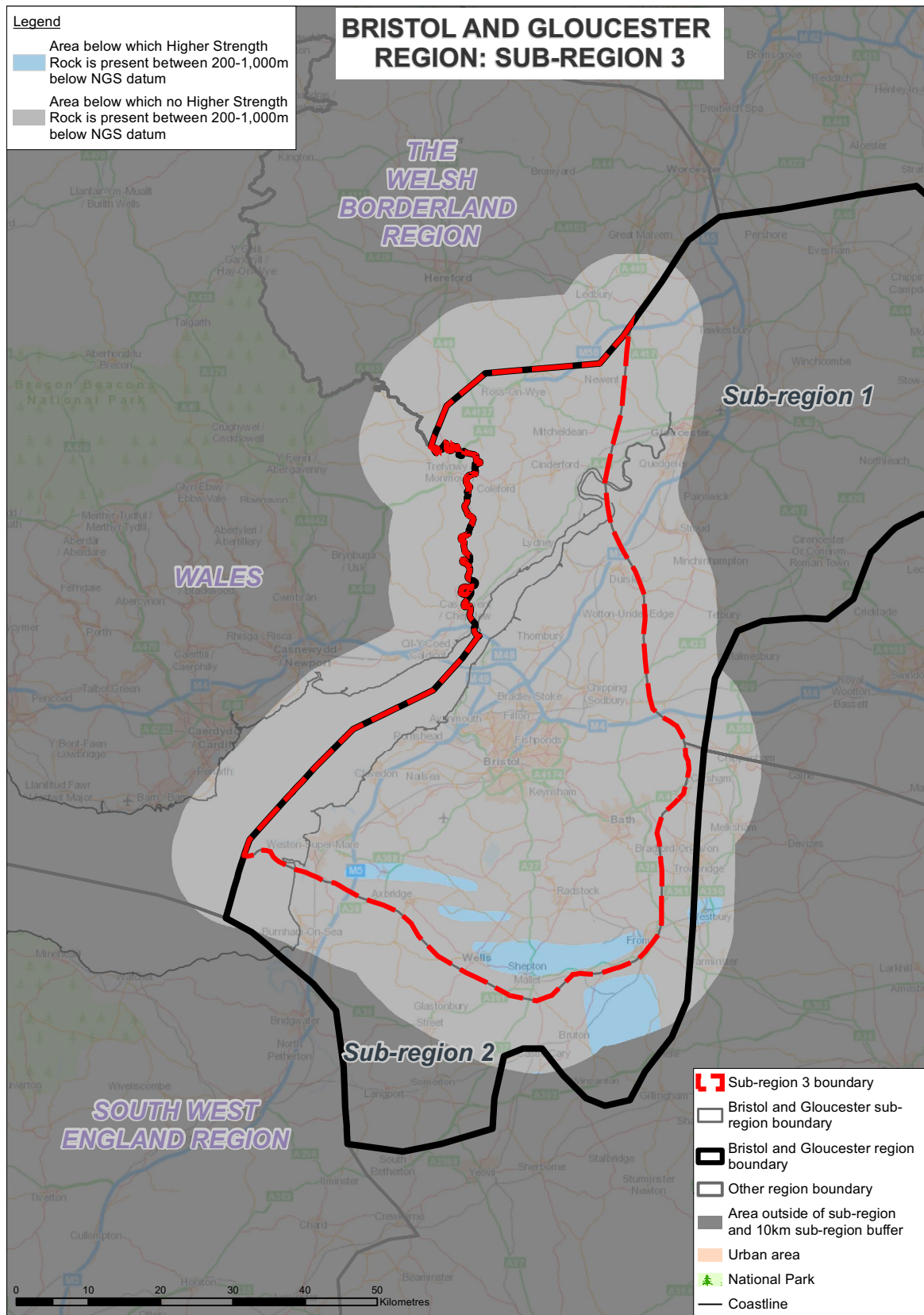




Figure 2 Location of major faults and folding in the Bristol and Gloucester subregion 3.

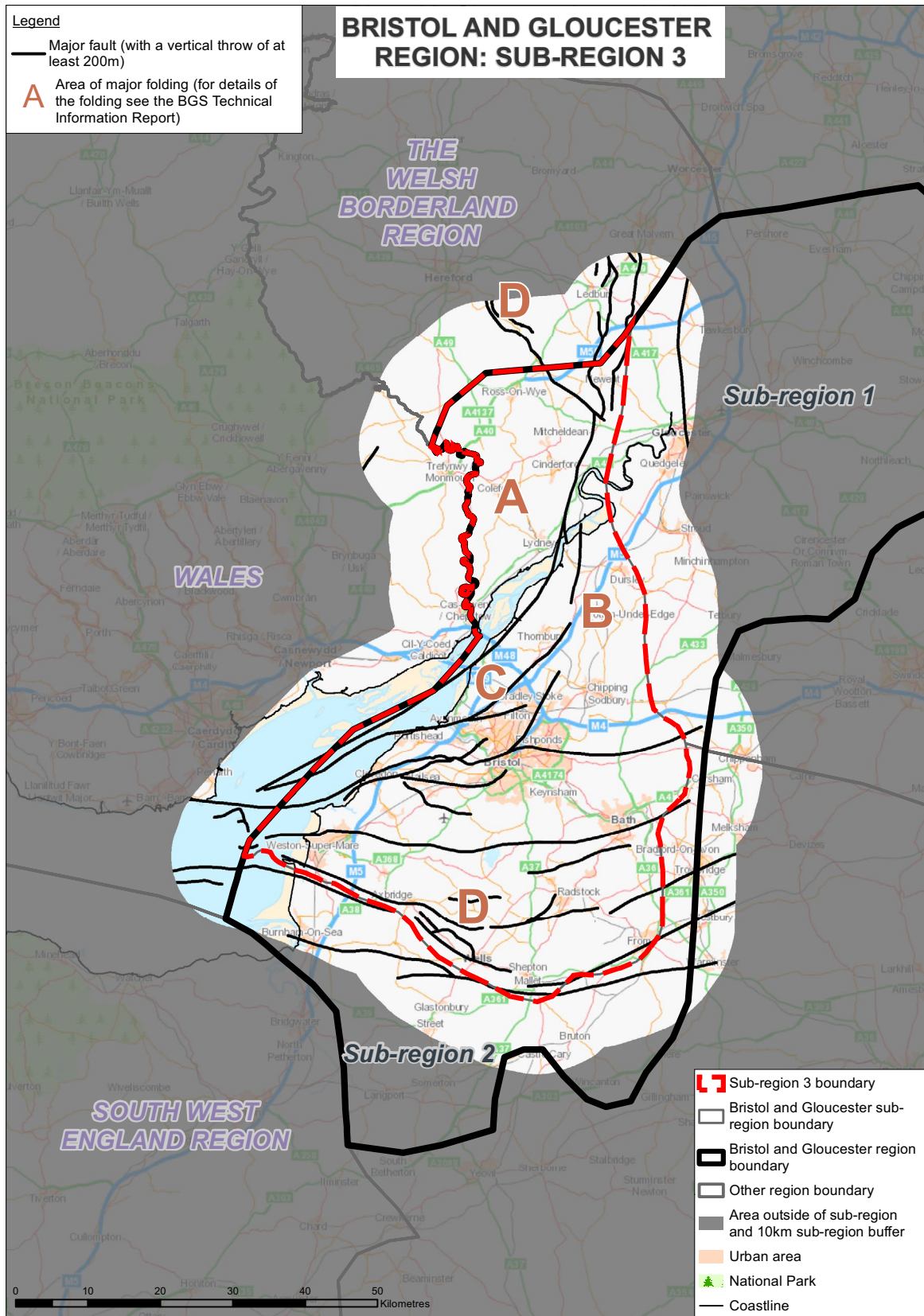




Figure 3 Areas of the Bristol and Gloucester subregion 3 with thermal springs and iron ore mines present below 100m.

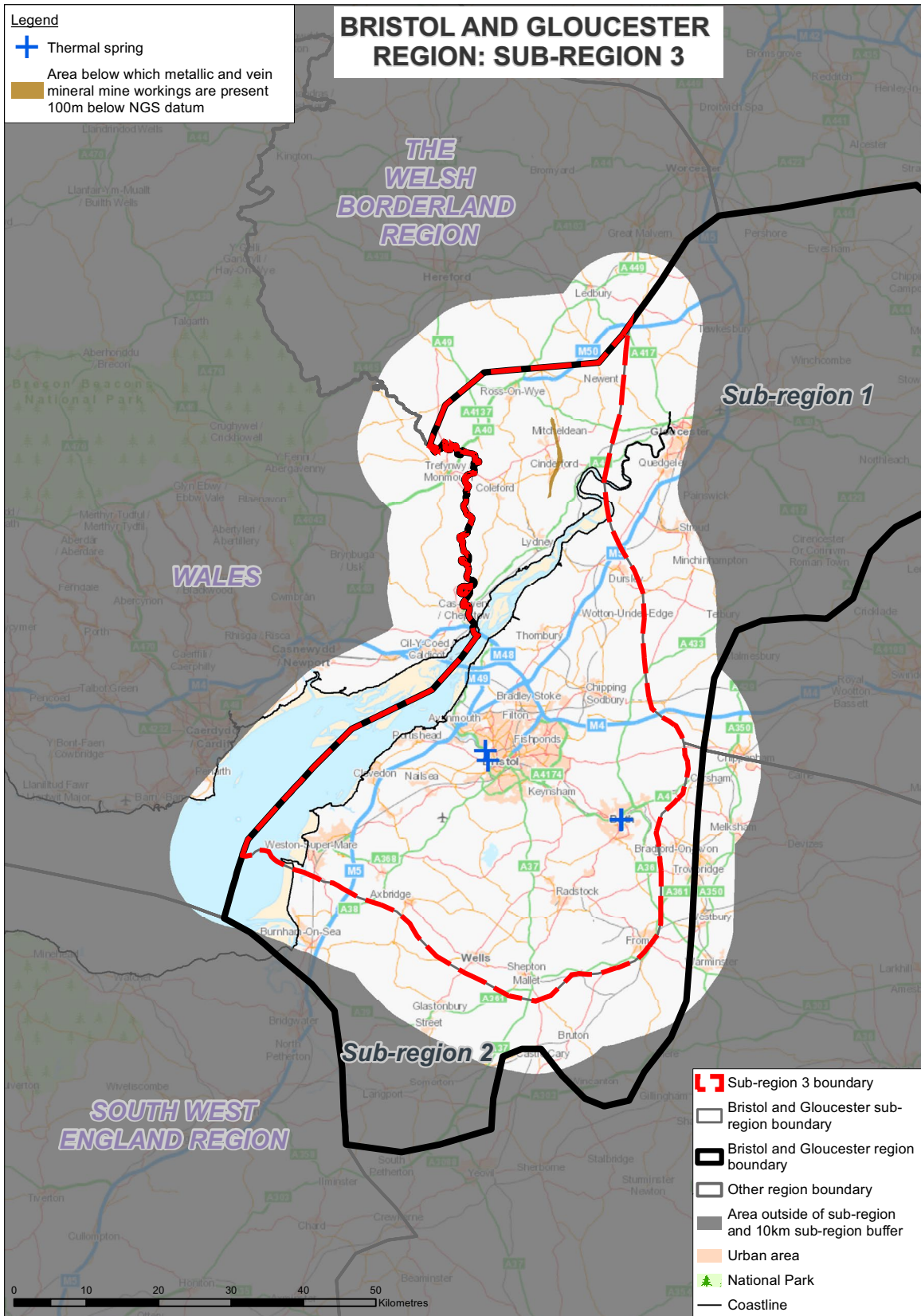




Figure 4 Areas in the Bristol and Gloucester subregion 3 with concentrations of deep exploration boreholes.

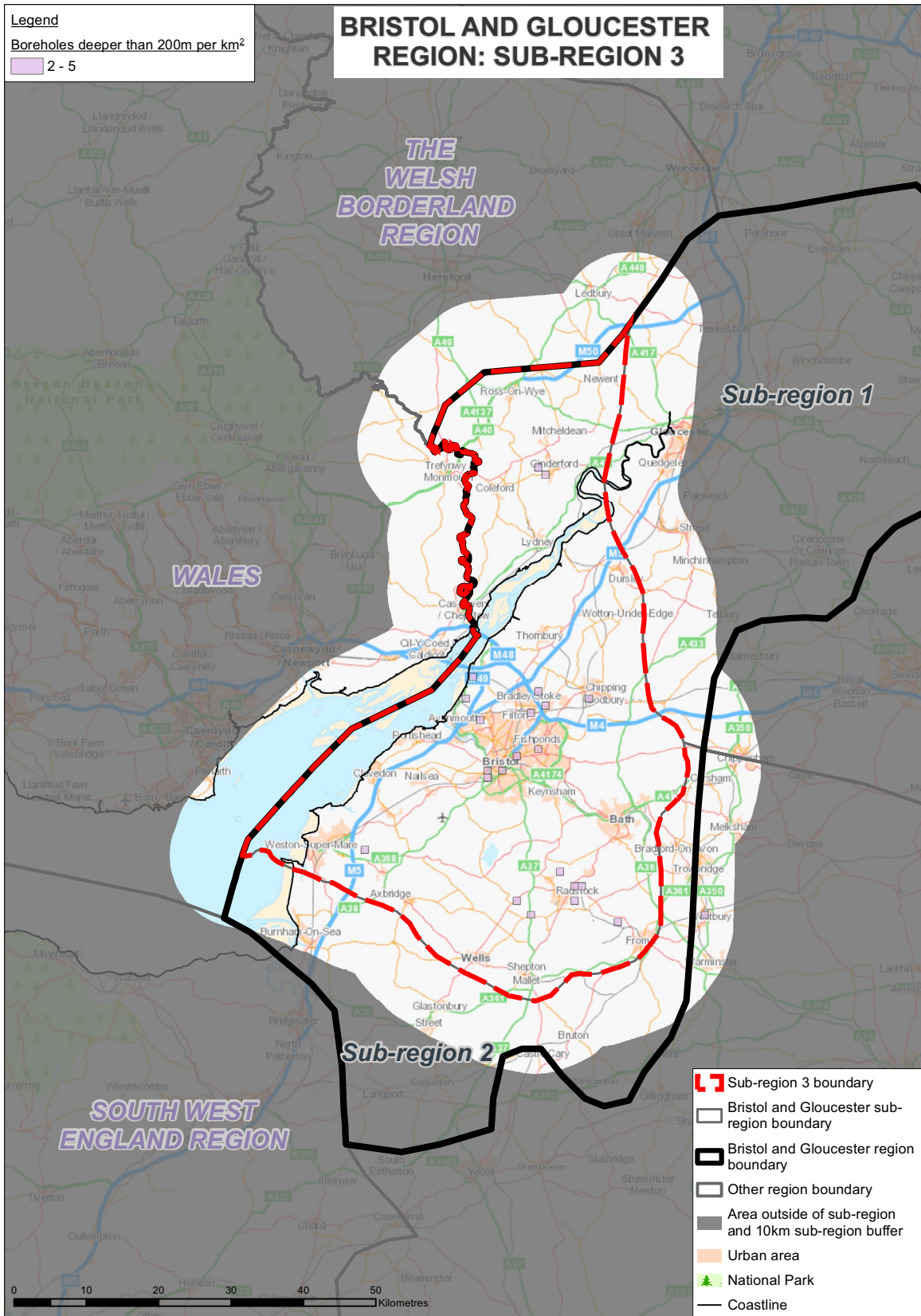




Figure 5a Areas of the Bristol and Gloucester subregion 3 with coal mines more than 100m deep and Coal Authority Licence Areas.

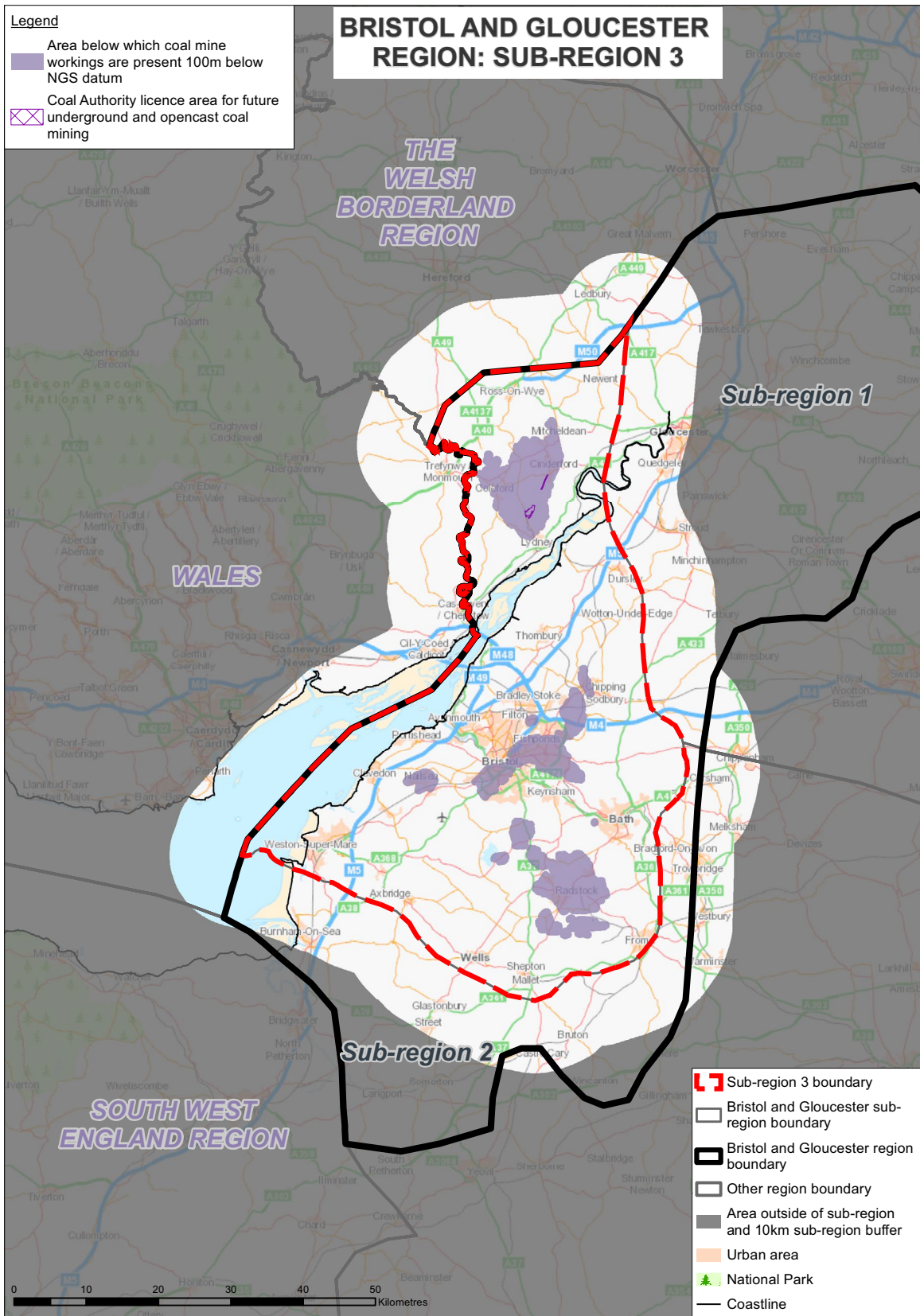




Figure 5b Areas of the Bristol and Gloucester subregion 3 with Petroleum Exploration and Development Licences.

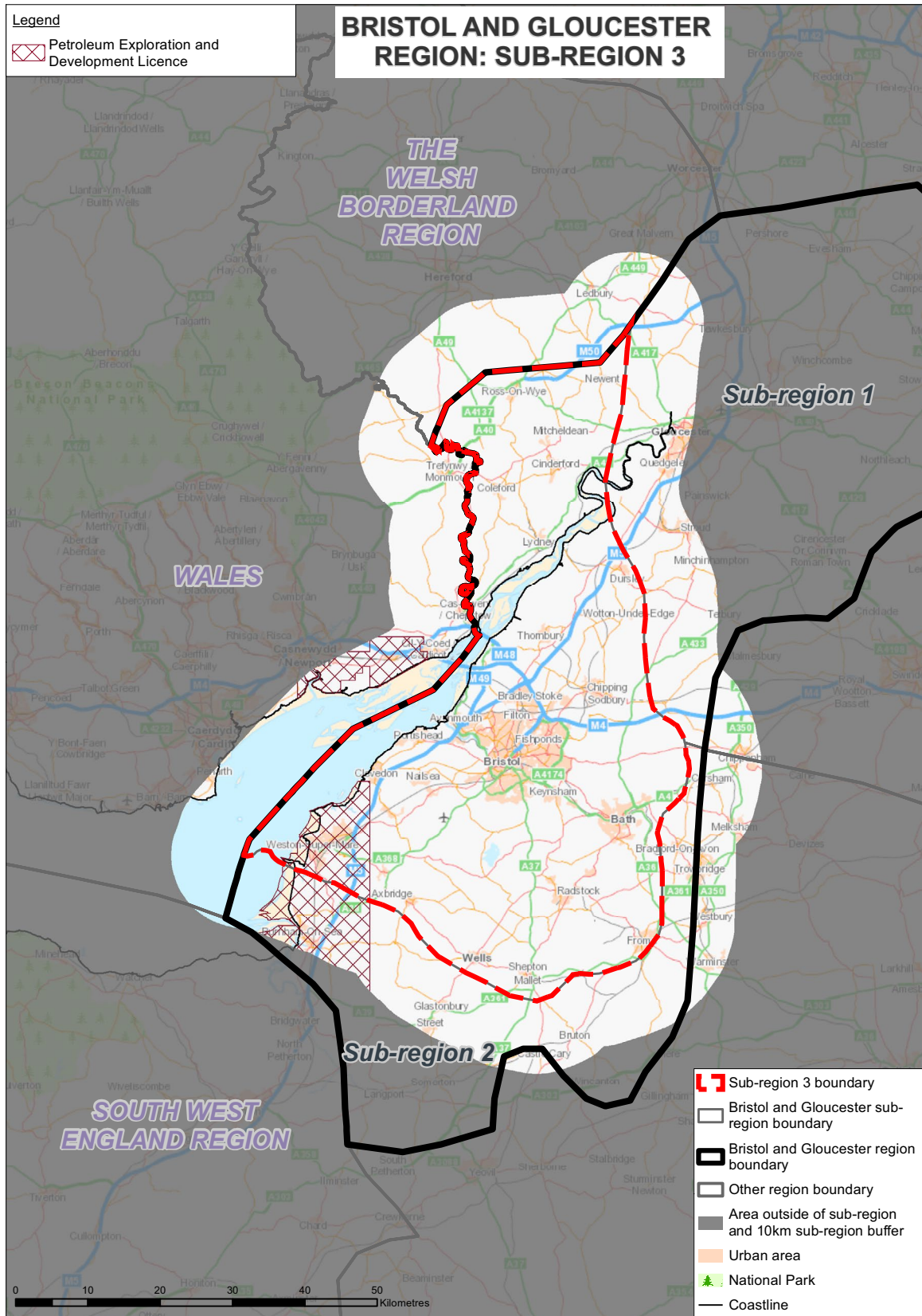
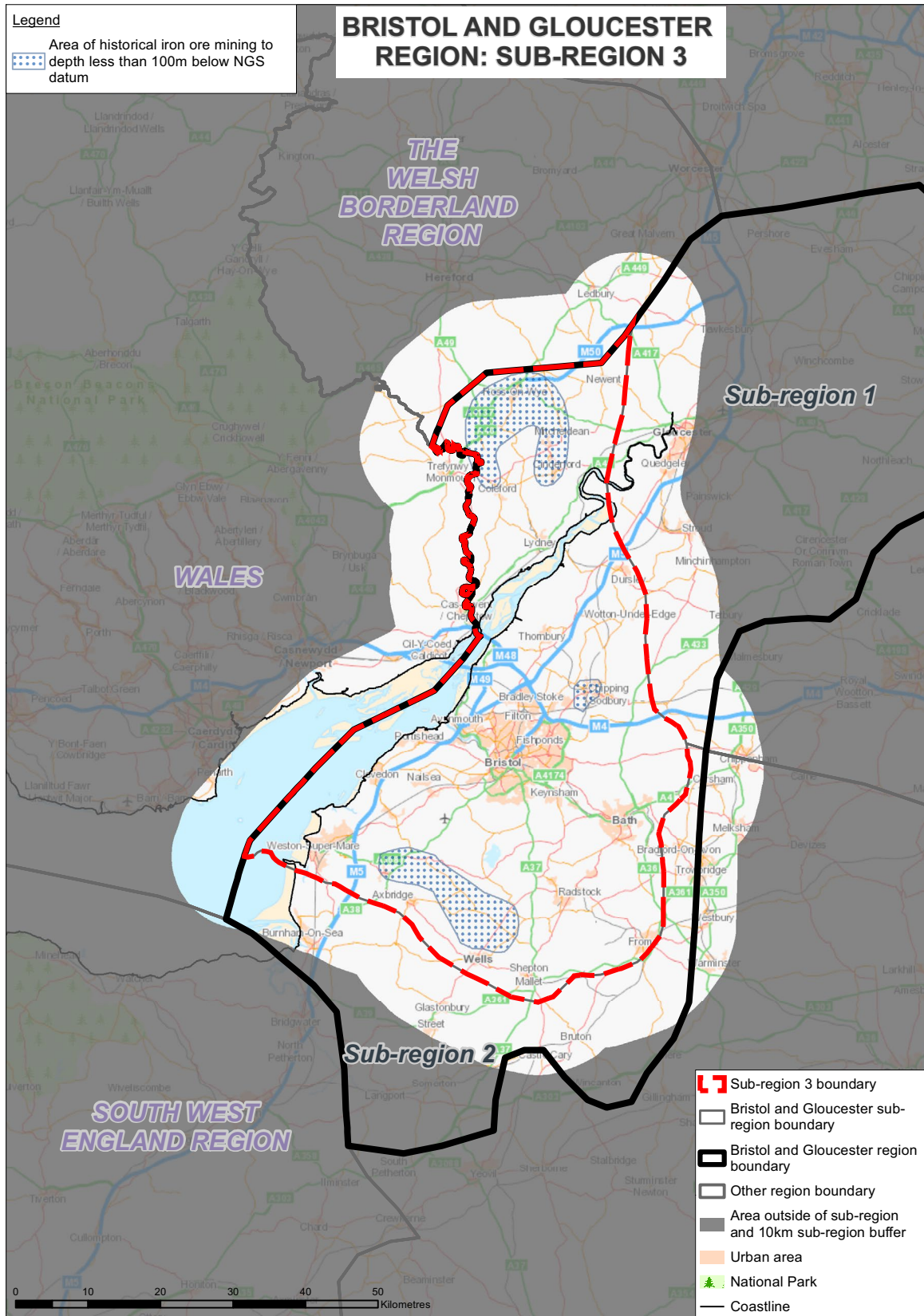




Figure 6 Areas of the Bristol and Gloucester subregion 3 with historical iron ore mines less than 100m deep.





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.

Fracture

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

Karst

A distinctive type of landscape consisting of deep cracks and caves in limestones. Karst forms due to the action of mildly acidic groundwater dissolving the limestone.

Lava flow

A mass of flowing or solidified lava. After cooling and solidification, lava flows often form distinctive topographical features.

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.

Sediments

Solid fragmented material, such as silt, sand, gravel and other material (including chemical precipitates, like salt), deposited in rivers, lakes, seas and oceans. Generally, the material that accumulates has originated from the weathering of other rocks. This material is often transported by erosion and deposited in layers. Sediments form the building blocks of sedimentary rocks (see below).



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