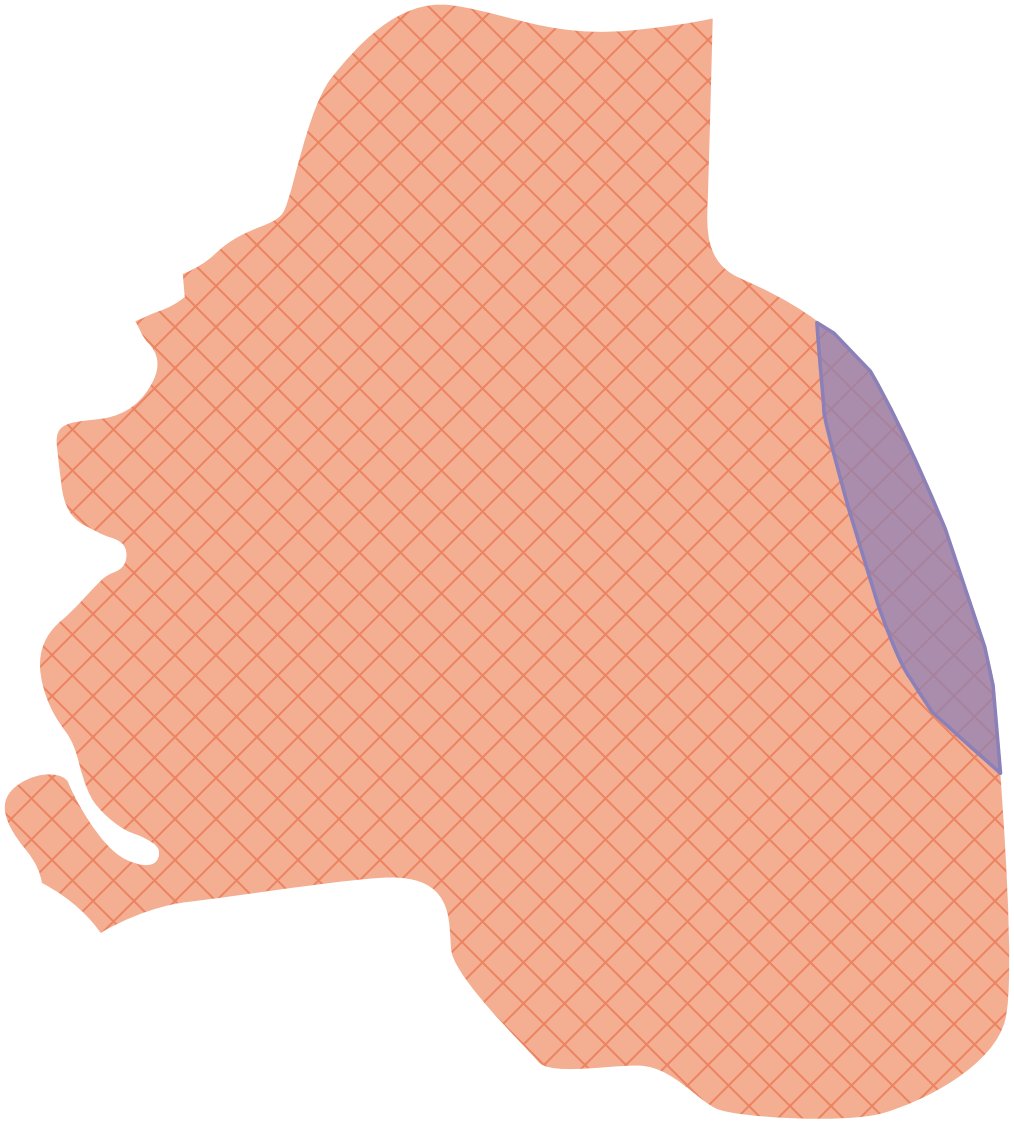
Radioactive Waste Management



Pennines and adjacent areas

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 a small part of this subregion, but the thickness and properties of the potential host rocks present may not be suitable.

Rock cannot generally be seen at the surface in this subregion, except in man-made excavations such as quarries or road cuttings. However, deep boreholes and geophysical investigations, particularly in the mining areas around Selby and north-east of Doncaster, give us an understanding of the rocks present and their distribution.

There are rock salt layers under and to the east of Selby in which it may be possible to site a GDF. The available information suggests that they may be too thin and 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 for coal to depths below 100m around Selby and to the north-east of Doncaster and there are known oil resources to the east of Doncaster. In these areas the mining and drilling are 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 this area, to the west of York and east of Doncaster, have Petroleum Exploration & 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.

Parts of this area, to the north-east of Doncaster, are 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 also continue to monitor how this exploration programme progresses.

Introduction

This subregion corresponds to a small area at the eastern margin of the Pennines and adjacent areas region with geology that is more closely related to subregion 4 of the adjacent Eastern England region.

Rock type

There are layers of rock salt (halite) belonging to the Zechstein Group within the depth range of interest in this subregion which are potential Evaporite host rocks (Figure 1), there are no Lower Strength Sedimentary Rocks (LSSR) or Higher Strength Rocks (HSR) in the subregion. The Zechstein rocks occur at the surface in a belt extending from Nottingham to Ripon and include layers of limestone and dolomite as well as bodies of rock salt, anhydrite and gypsum. These units dip gently east and rock salt occurs within the depth range of interest in the Selby area. The layer containing the rock salt is likely to be about 20m thick in this subregion based upon oil and gas exploration boreholes to the east in the Eastern England region. The thickness of the rock salt may vary considerably and so thicker bodies or lenses could occur. The rock salt may not have potential as Evaporite host rocks under much of this subregion because it may be too thin and interlayered with permeable limestones and sandstones.

A summary of the geological attributes of the Pennines and adjacent areas 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 Rock Types of Interest in this subregion are part of the younger sedimentary rocks and are typically not significantly folded with only minor faulting (Figure 2). Faults may act as barriers to or pathways for groundwater movement, depending upon their characteristics, and the siting of a GDF would need to take account of them[1].

[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

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, including the Sherwood Sandstone Group, several beds within the Zechstein Group and the Rotliegendes Group. Water moves to the east, through these rock layers which become progressively deeper towards the coast. Groundwater several tens of thousands of years old has been sampled from boreholes in the Sherwood Sandstone Group, where it is separated from the surface by the overlying Mercia Mudstone Group in the east of the subregion. There is also evidence for the presence of brines that are millions of years old in the underlying Carboniferous Limestone aquifer. Groundwater from depths greater than 400m is unlikely to be suitable as drinking water anywhere in the UK[2].

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. In parts of the subregion deep exploration boreholes may influence the connectivity between shallow and deep groundwater which would also 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.

[2] Water Framework Directive UK TAG. Defining and reporting on groundwater bodies, 2012.

Resources

Coal has been mined extensively in this subregion with mining extending below 100m around Selby and north-east of Doncaster (Figure 4a). There are also small oil fields east of Doncaster (Figure 4b). 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.

A number of Petroleum Exploration and Development Licences[3] are currently held in the subregion to the west of York and east of Doncaster (see Figure 4b). There are also Coal Authority Licence Areas to the north-east of Doncaster (Figure 4a). 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.

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.

[3] This also includes other licences awarded by the Oil and Gas Authority to allow companies to explore for hydrocarbons.

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

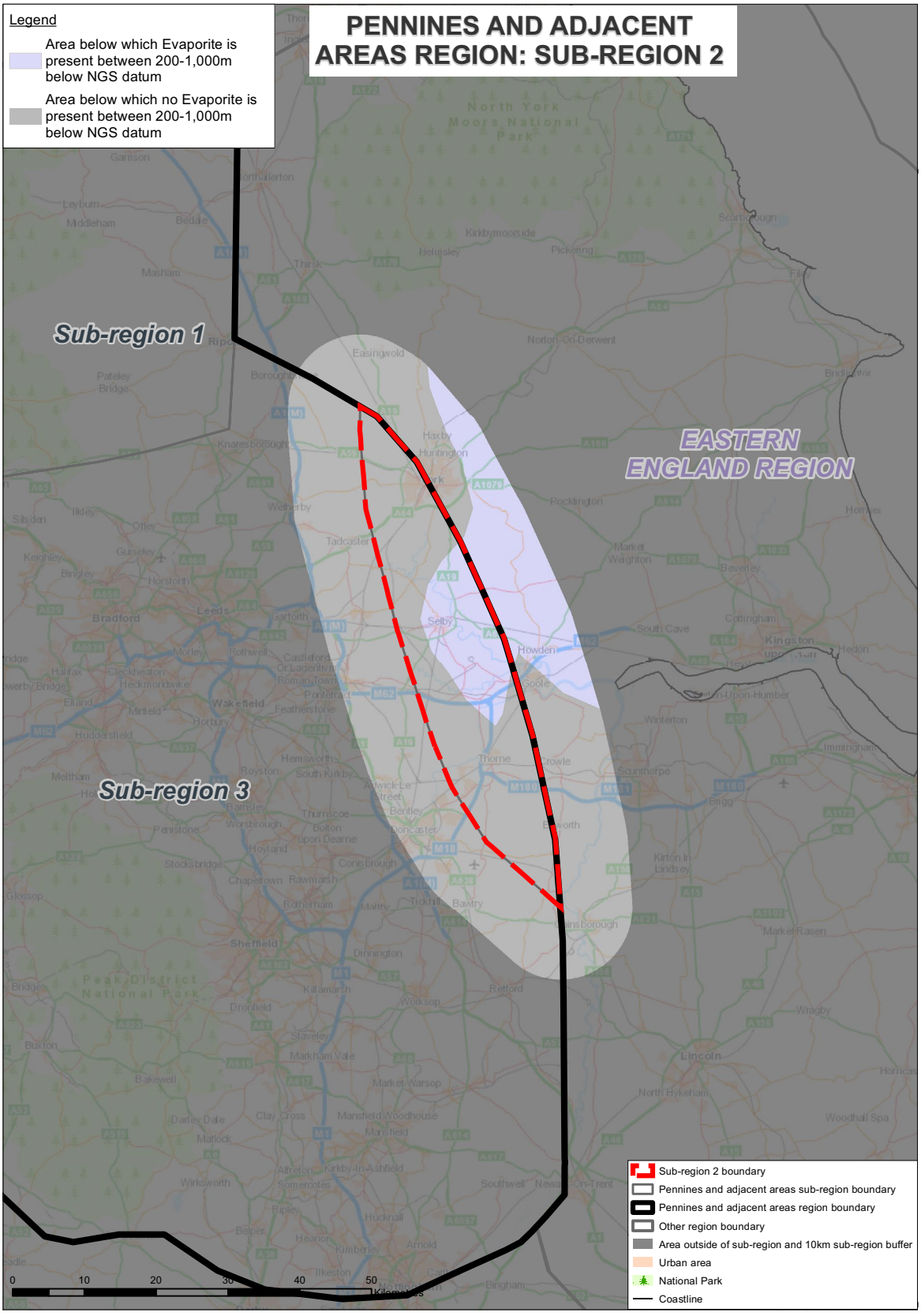


Figure 2 Location of major faults in the Pennines and adjacent areas subregion 2.

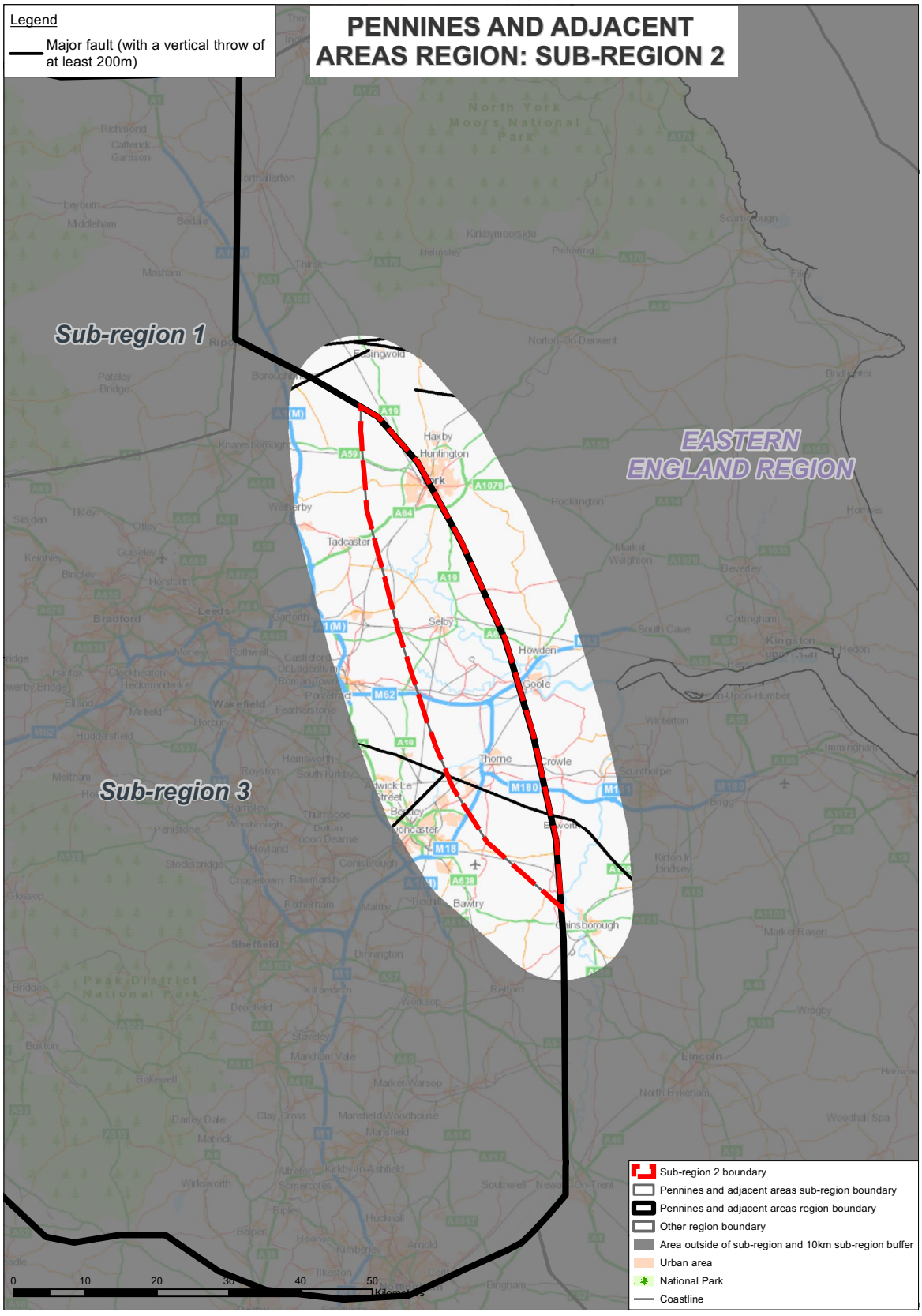


Figure 3 Areas in the Pennines and adjacent areas subregion 2 with concentrations of deep exploration boreholes.

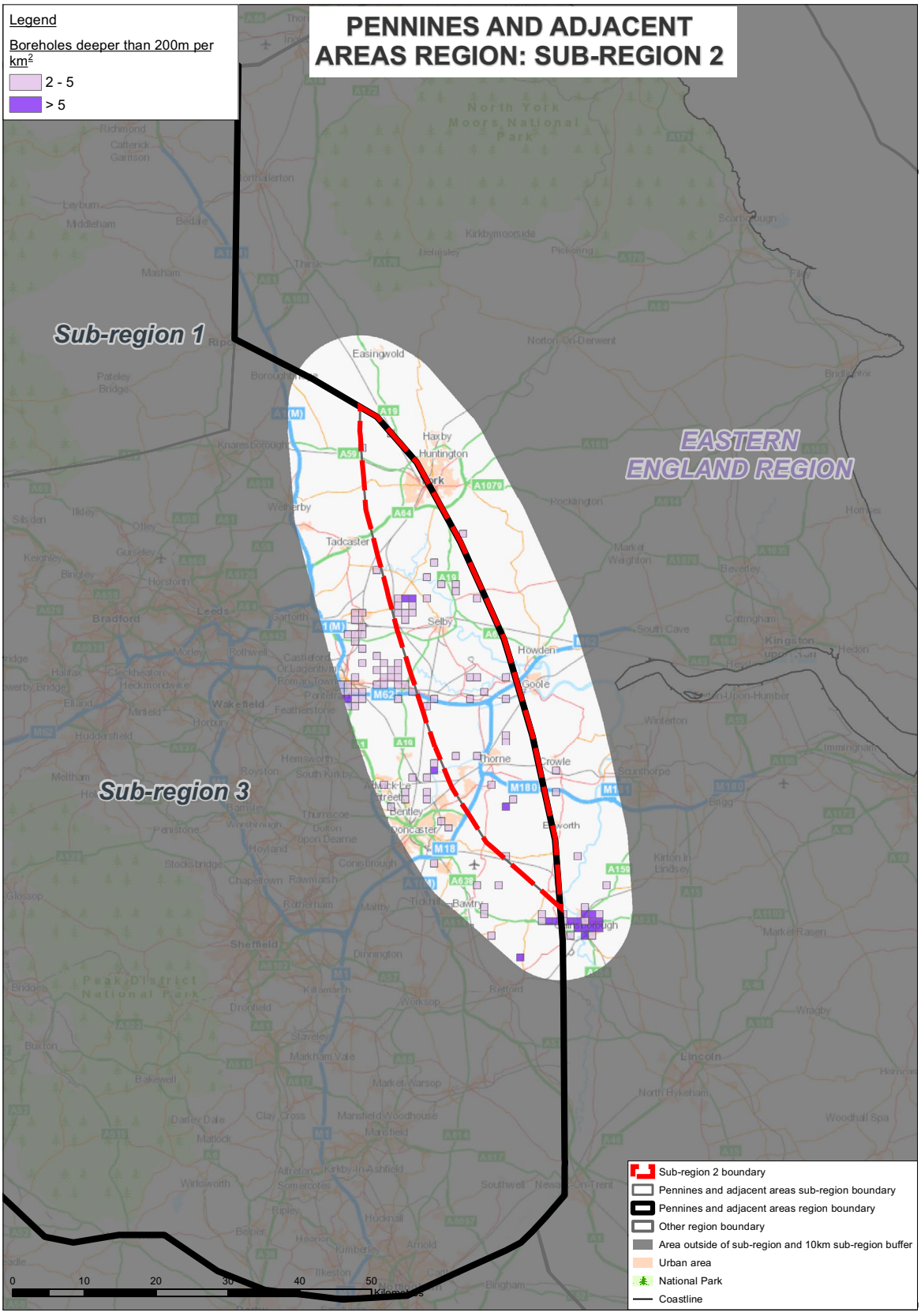


Figure 4a Areas of the Pennines and adjacent areas subregion 2 with coal mines present below 100m and Coal Authority Licence Areas.

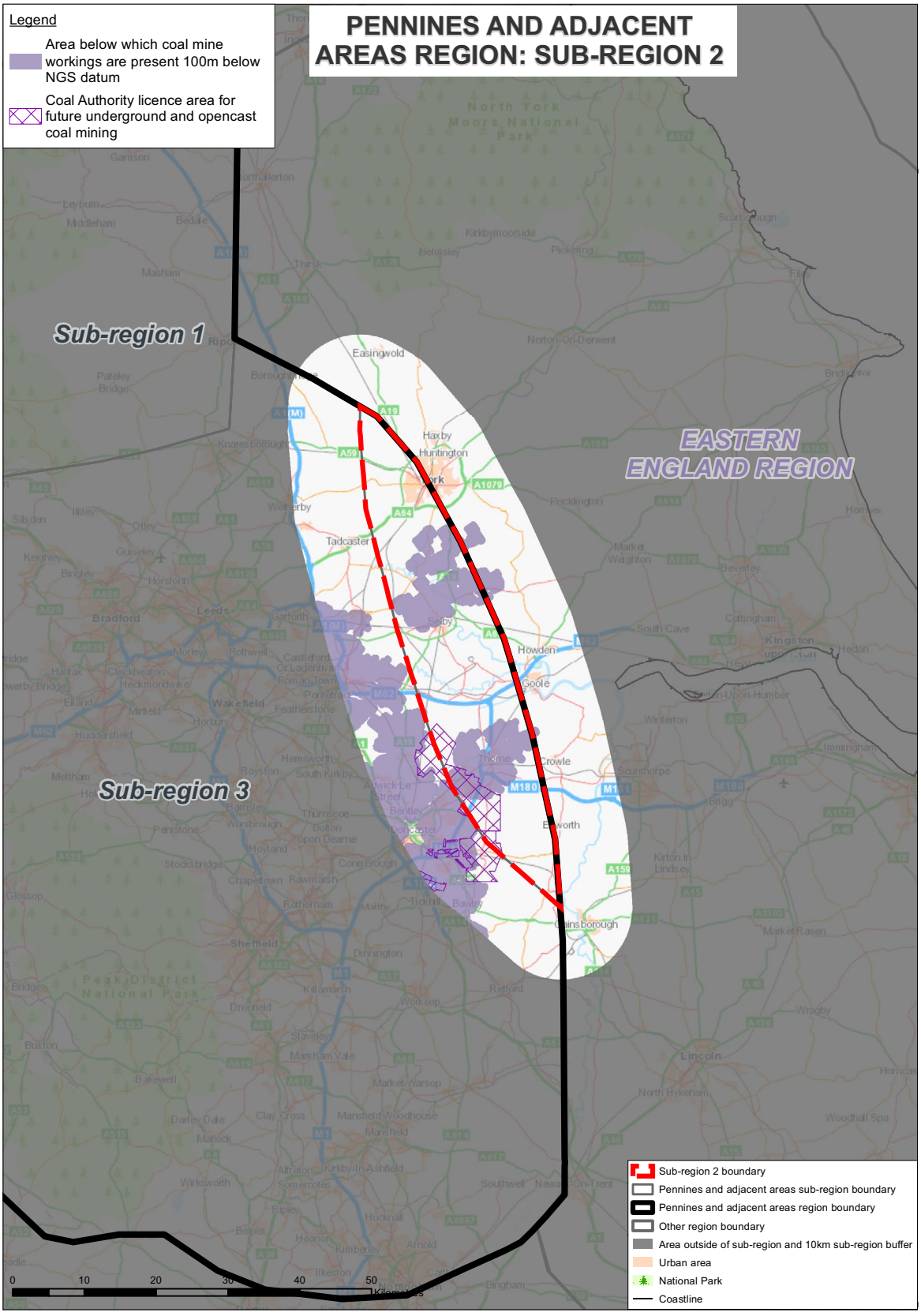
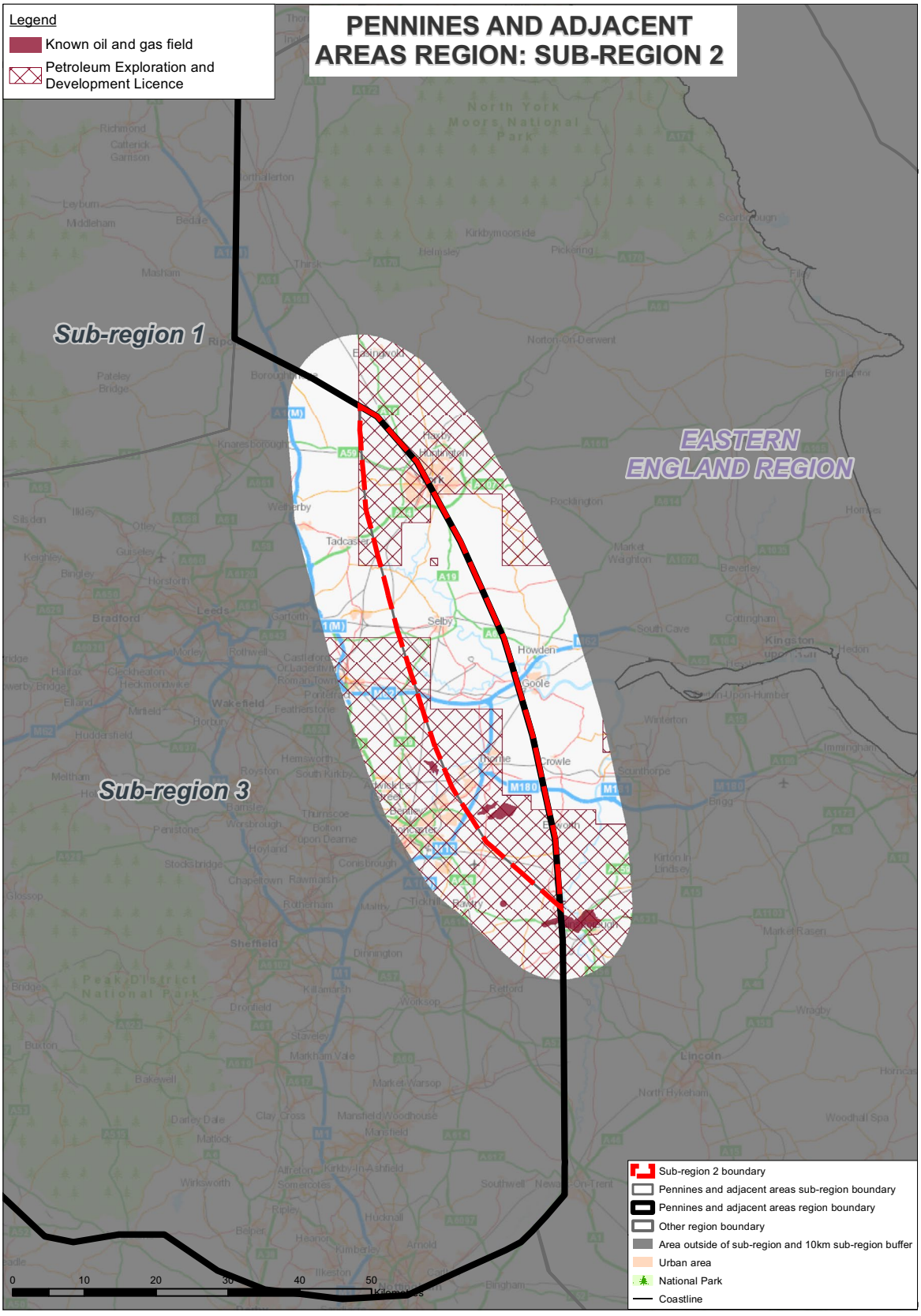


Figure 4b Areas of the Pennines and adjacent areas subregion 2 with oil and gas fields and Petroleum Exploration and Development Licences.



Glossary

Anhydrite
A calcium sulphate mineral that forms from the evaporation of salty seas. It contains no water and occurs at greater depths and higher temperatures than gypsum.

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

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

Dolomite
Magnesium carbonate mineral which often is found in limestones.

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'.

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.

Radioactive Waste Management

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