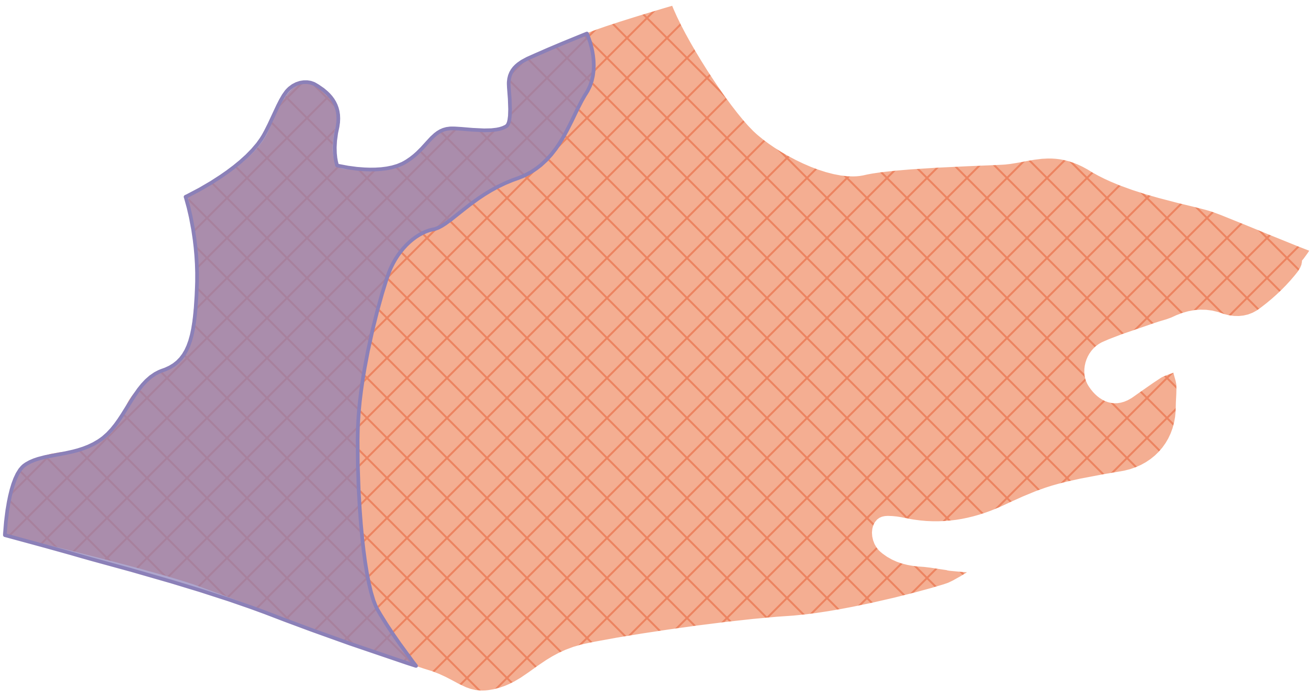
Radioactive Waste Management



London and the Thames Valley

SUBREGION 3

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.

Although rock cannot generally be seen at the surface in this subregion except in man-made excavations such as quarries and road cuttings, numerous 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 granites and similar strong rocks to the north of Milton Keynes, in which we may be able to site a GDF. These rocks have only been found in a handful of boreholes and we would need to do more work to find out whether these rocks have suitable properties and thicknesses in the depth range of interest for a GDF.

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.

Introduction

This subregion comprises the part of the London and the Thames Valley region west of Olney, Buckingham, Oxford, Reading and Aldershot.

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 this subregion comprises a well-known sequence of sedimentary rocks throughout the depth range of interest with several Lower Strength Sedimentary Rock (LSSR) units present including the Gault, Kimmeridge and Oxford Clay Formations and Lias and Mercia Mudstone Groups. Outcrops and boreholes within the London and the Thames Valley region show the Gault, Kimmeridge and Oxford Clay Formations are formed predominantly of mudstones with some siltstone. The Lias and Mercia Mudstone Groups comprise mudstones interlayered with other sedimentary rocks. The Lias Group is between 200 and 400m thick and, although mudstones dominate, they are interbedded with thin limestones and sandstones over much of the sequence. It is unlikely that individual mudstones are thick enough to act as a host rock, but the Lias Group provides an effective barrier to vertical movement separating deep and shallow groundwater. The Mercia Mudstone Group is also up to 400m thick and is composed largely of mudstone with siltstone, sandstone and evaporite (gypsum and anhydrite) layers. Further information on all of these LSSR units, and the Lias Group and Mercia Mudstone Group in particular, would be required to evaluate their potential as host rocks.

Deep boreholes have shown that these LSSR units each attain thicknesses of more than 100m in this subregion. Where individual mudstone beds are tens of metres thick, the units are potential LSSR hosts. Even where this is not the case, they serve to separate the groundwater in the rocks beneath from groundwater above and so could contribute to the safety of a GDF hosted in the underlying rocks. 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.

Basement rocks only occur in this subregion within the depth range of interest between Northampton and Milton Keynes. There is little information on the nature of these basement rocks at these depths, nor the folding and faulting affecting them, and further information on these attributes would be required to evaluate their potential as Higher Strength Rock (HSR) host rocks.

A summary of the geological attributes of the London and the Thames Valley 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

These rocks are not strongly folded and there are only a few major faults (see 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].

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. Several principal aquifers are present in this subregion including the Chalk Group and the Upper and Lower Greensand and Portland Stone Formations and the Great and Inferior Oolite Groups. Karstic conditions have developed in some places in the Chalk aquifer, where concentration of groundwater flow has enlarged fractures by dissolution to form a network of major fissures, resulting in fast movement of groundwater near the surface. Although fresh groundwater is abstracted from all of these aquifers across the subregion, this is generally only from depths of less than 200m. Groundwater from depths greater than 400m is unlikely to be suitable as drinking water anywhere in the UK[2].

The numerous layers of LSSR described above are likely to provide hydraulic separation between the different aquifers and between deeper groundwater and the surface even where they are not thick enough to host a GDF. At greater depths and away from the surface recharge there are indications that the groundwater in at least some of these aquifers (e.g. Great and Inferior Oolite Groups) becomes saline due to long residence times of relatively stagnant water.

There are some areas around Banbury and Charlbury where deep exploration boreholes may influence the connectivity between shallow and deep groundwater which would need to be considered during the siting process (see 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

We consider it unlikely that there will be an increased likelihood of future human intrusion in this subregion due to future use of geological resources.

Iron ores occur in the Banbury and Northampton areas, which were mined on a modest scale in the 19th century, but neither workings nor resources extend more than 100m below NGS datum and therefore they are not considered to be a constraint on siting a GDF (Figure 4). The Oxfordshire and Berkshire Coalfield, which underlies the northern part of this subregion, has been evaluated but never mined: the coal seams are thin and of low quality. Although it is unlikely that they would be a commercially viable resource in the future they would be considered in the assessment of human intrusion during the siting process.

There is an Oil and Gas Authority Licence for a small area at the extreme southern limit of this subregion which is discussed under the Hampshire Basin and adjoining areas region.

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 London and the Thames Valley subregion 3 where any of the 3 Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

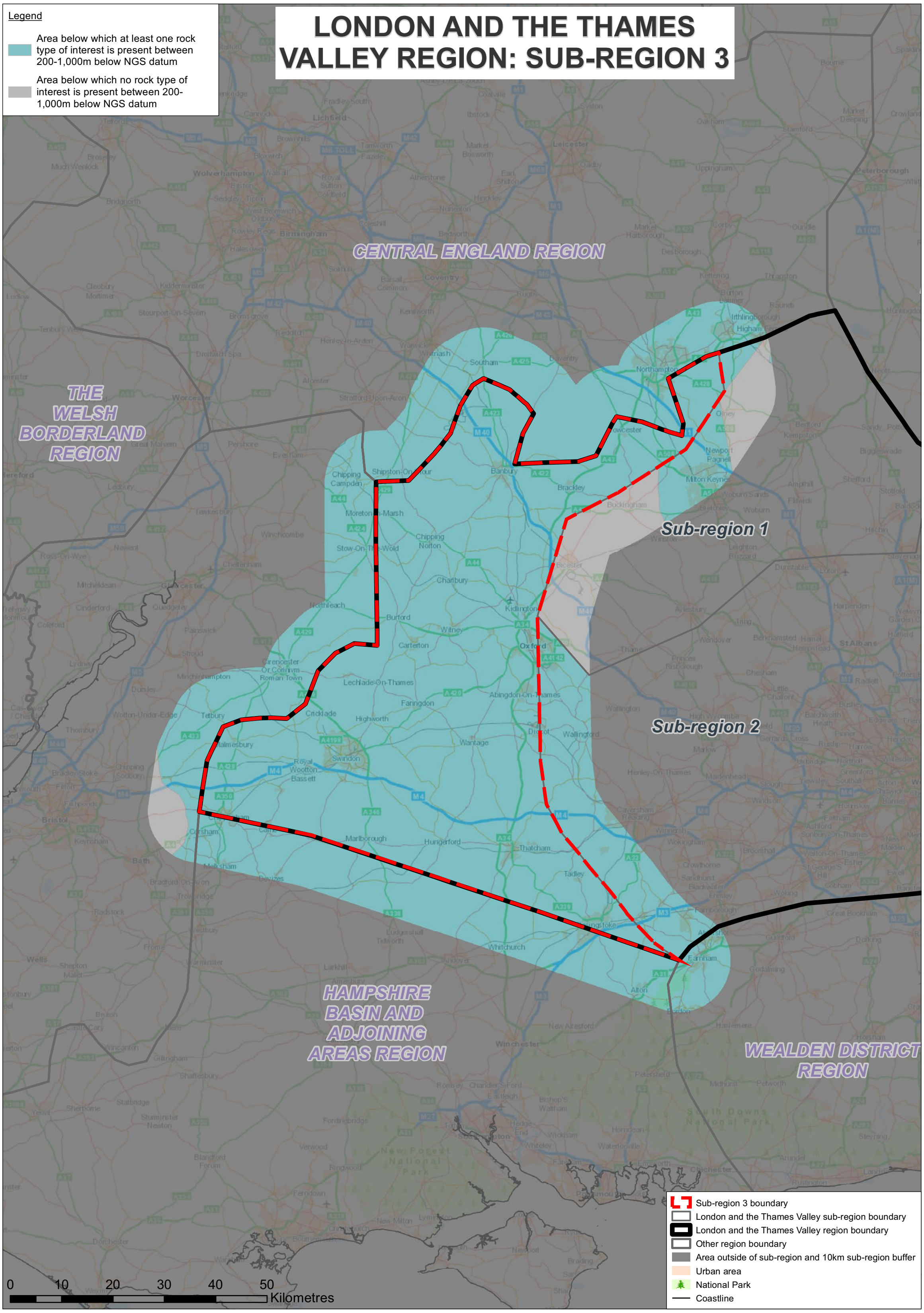


Figure 1b The areas of the London and the Thames Valley subregion 3 where Lower Strength Sedimentary Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

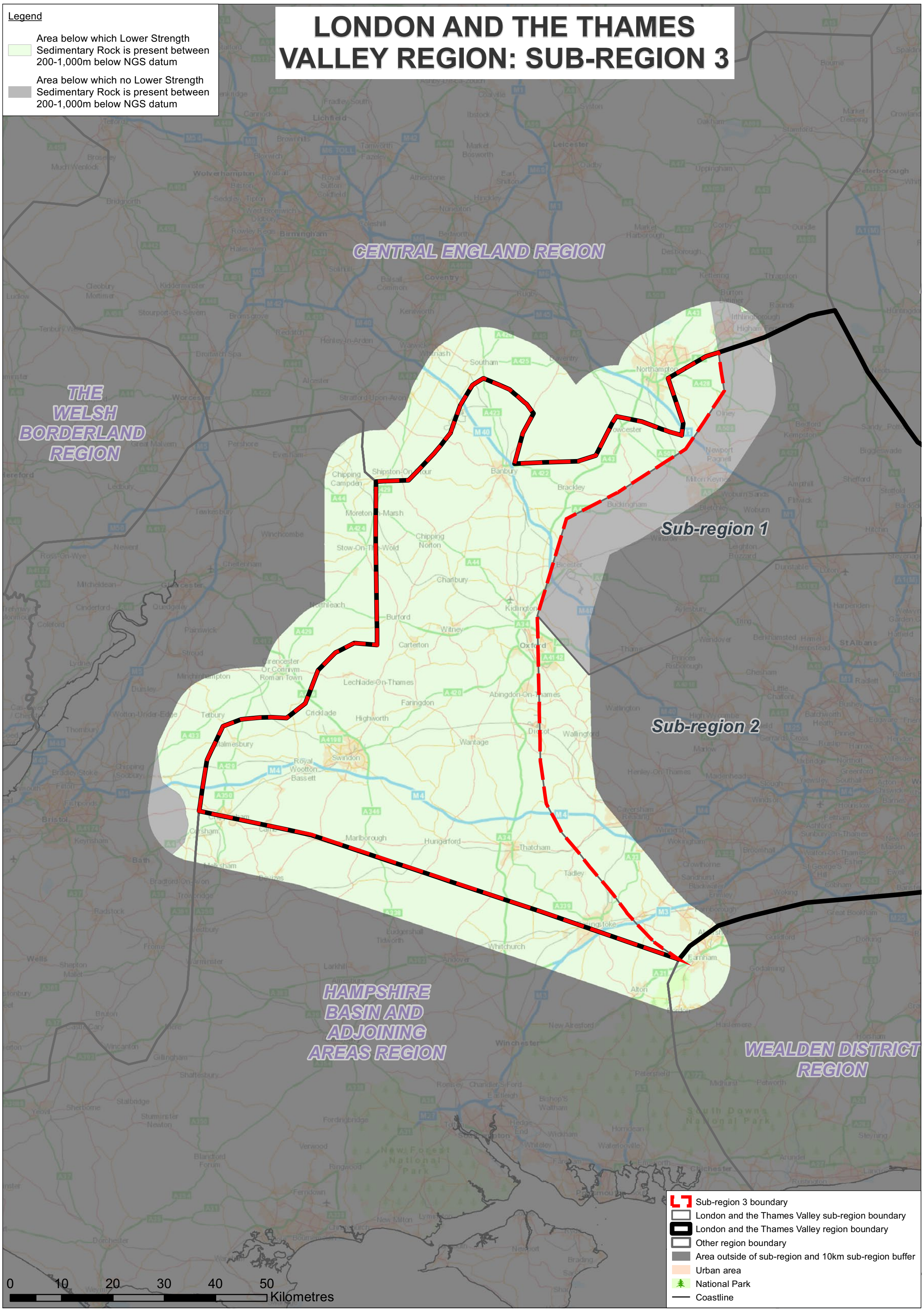


Figure 1c The areas of the London and the Thames Valley subregion 3 where Higher Strength Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

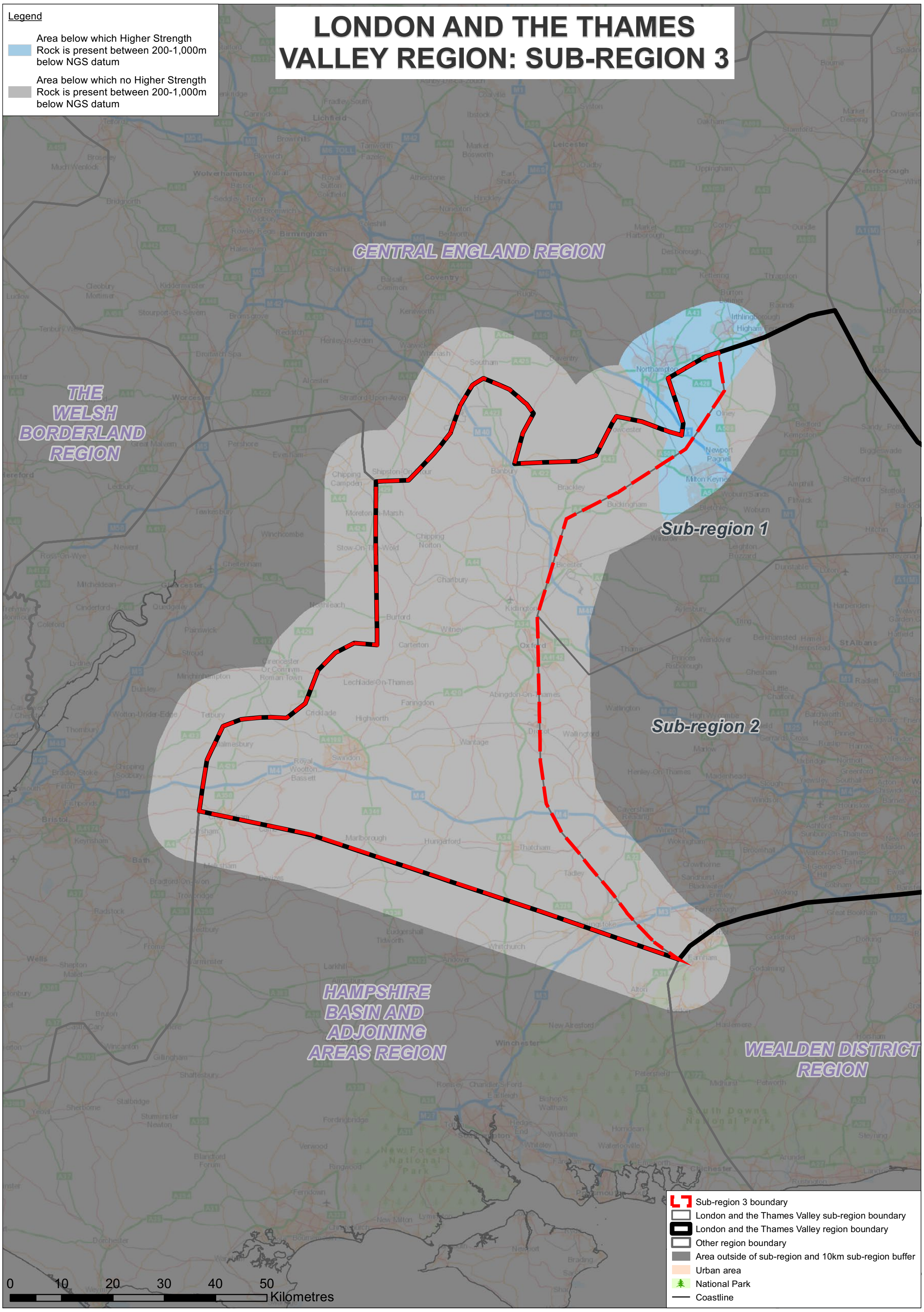


Figure 2 Location of major faults in the London and the Thames Valley subregion 3.

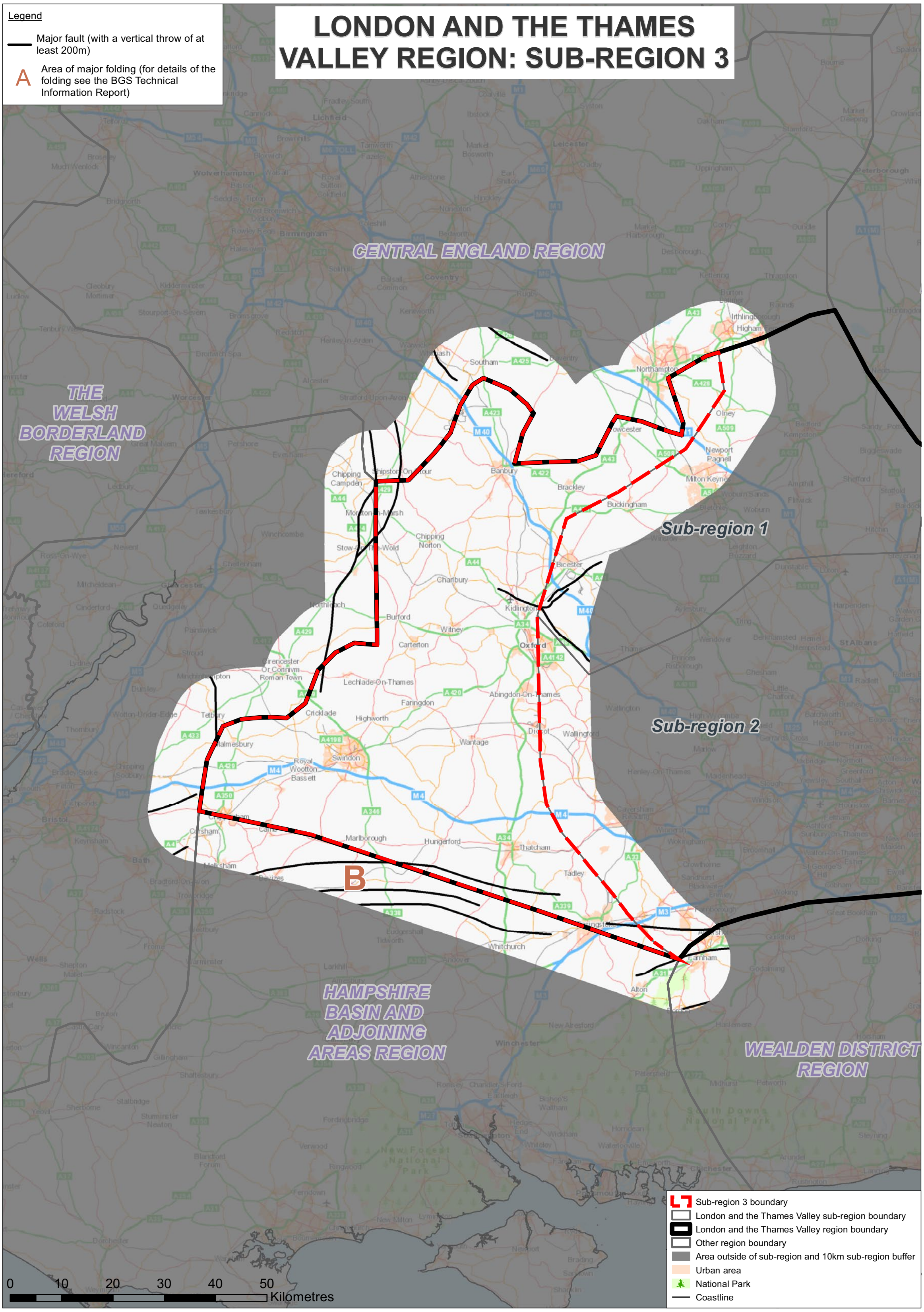


Figure 3 Areas in the London and the Thames Valley subregion 3 with concentrations of deep exploration boreholes.

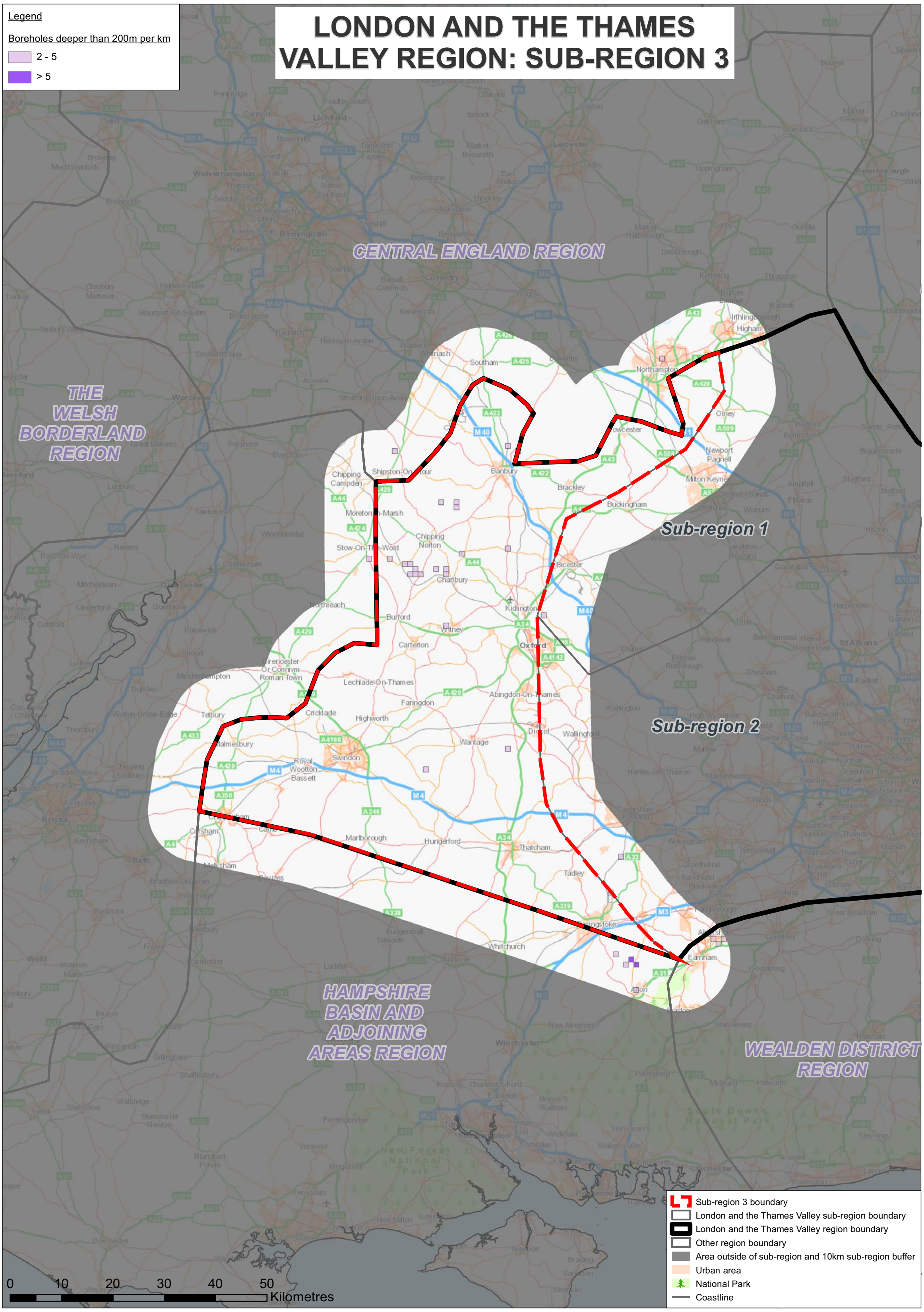
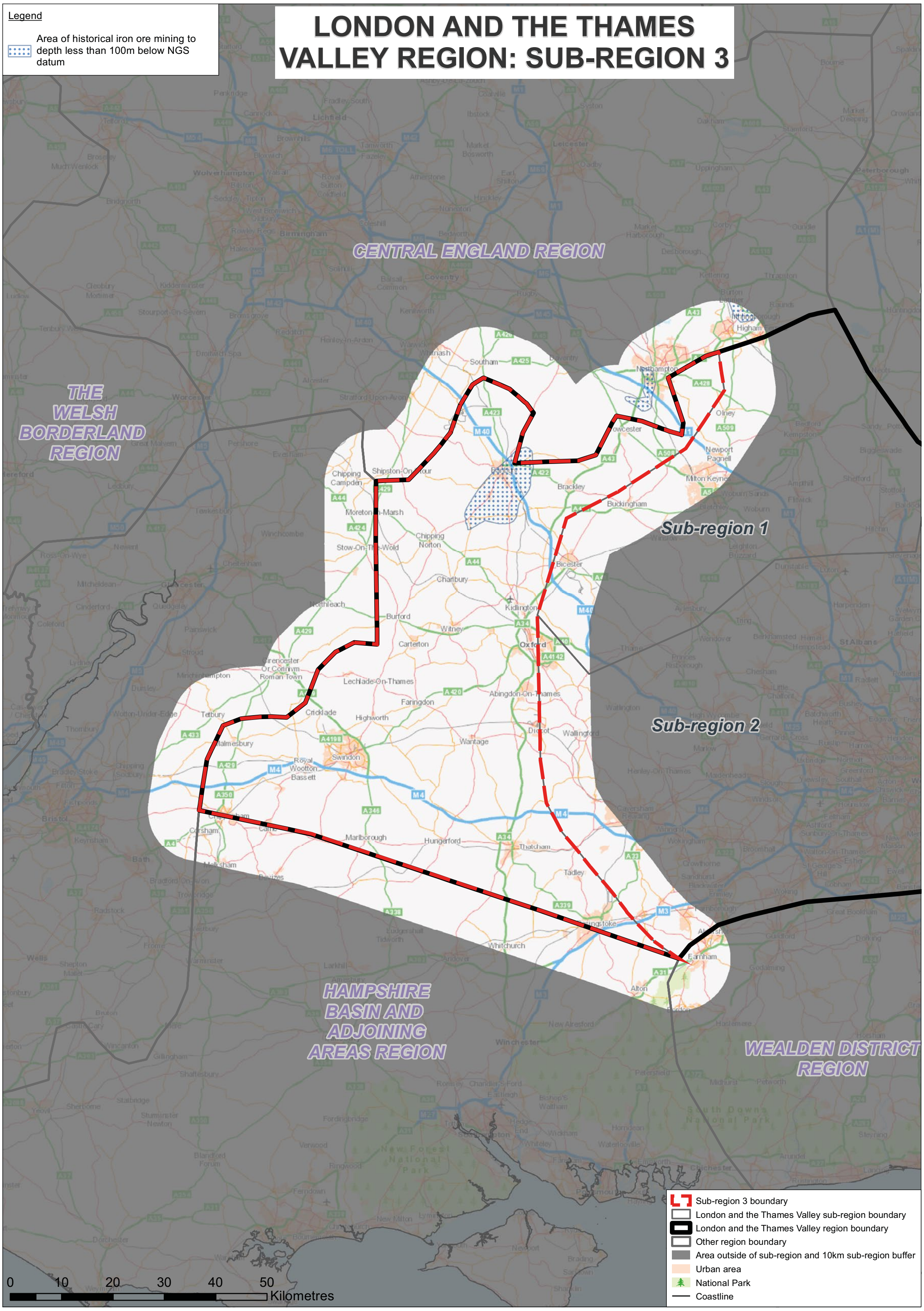


Figure 4 Areas of the London and the Thames Valley subregion 3 with historical iron ore mines less than 100m deep.



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.

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.

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.

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.

Outcrop
A visible exposure of bedrock on the surface.

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.

Saline
Containing salt (e.g. seawater is saline).

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.

Surface recharge
Water that is added to a groundwater reservoir from sources such as the direct infiltration of rainfall or from surface water like rivers or lakes crossing the aquifer.

Radioactive Waste Management

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