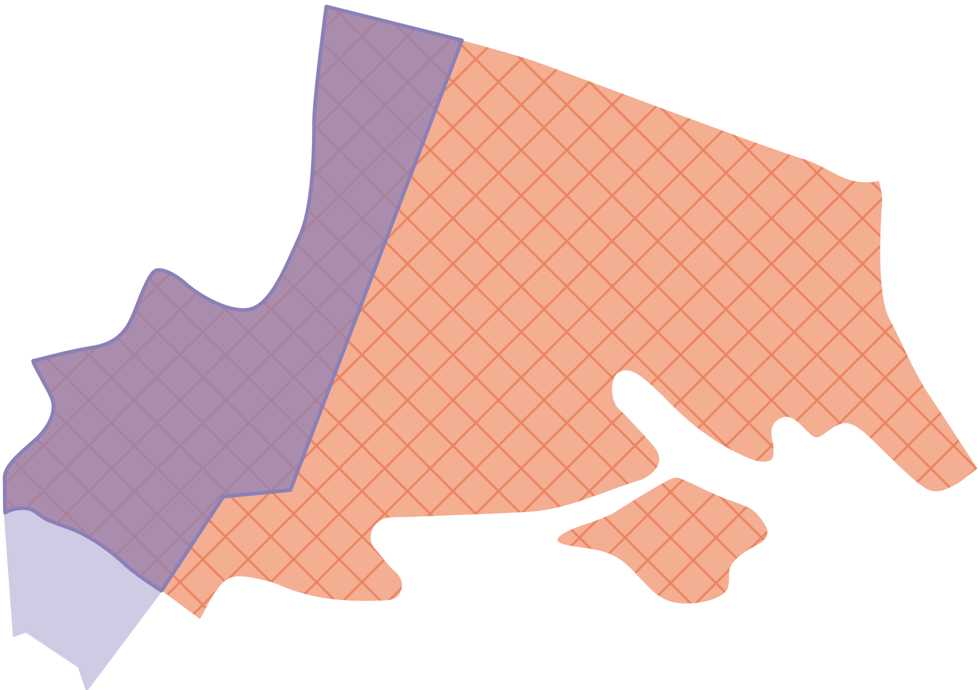
Radioactive Waste Management



Hampshire Basin

SUBREGION 1

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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 most of this subregion.

Rock can be seen at the surface in a few places in this subregion such as the sea cliffs around Bridport and 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 under the whole subregion in which we may be able to site a GDF. There are also layers of rock salt, between Sherborne and Bridport and extending under the English Channel, and slates and similar strong rocks, around Yeovil and Sherborne, 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 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 Hampshire and adjoining areas region west of a line through Dorchester, Shaftesbury and Devizes, including the adjacent inshore area which extends to 20km from the coast.

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 geology of this subregion comprises a reasonably well-known and predictable sequence of sedimentary rocks throughout the depth range of interest with 2 Lower Strength Sedimentary Rock (LSSR) units present; the Lias and Mercia Mudstone Groups. Deep boreholes have shown that these LSSR units reach thicknesses of more than 100m in this subregion; the Lias Group up to 450m and the Mercia Mudstone Group up to 950m. The Dyrham, Charmouth Mudstone and Blue Lias Formations of the lower and middle Lias Group comprise thick sequences dominated by mudstone. However, all 3 units also contain frequent layers of sandstone or limestone. It is unlikely that individual mudstones are thick enough to act as a host rock, but the Lias Group is likely to provide an effective barrier to vertical movement between deep and shallow groundwater. Further investigations would therefore be needed to confirm whether the Lias Group is suitable to host a GDF in any given location.

The Mercia Mudstone Group is dominated by mudstones with small amounts of sandstone and gypsum and anhydrite in nodules and veins. The extensive mudstone units 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. 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.

The Dorset Halite Member of the Mercia Mudstone Group was found to be 120m thick at the bottom of the depth range of interest in the Nettlecombe borehole north-east of Bridport and it is also present in the Marshwood-1 borehole to the north-west of Bridport. The thickness and distribution of this layer within the depth range of interest is not well known and further information would be needed to assess its suitability to host a GDF.

Irrespective of their suitability as host rocks, the Lias and Mercia Mudstone Groups would serve to separate groundwater in the rocks beneath from the groundwater above and so could contribute to the safety of a GDF hosted in the underlying rocks. The Mercia Mudstone Group is an effective cap rock acting as an overlying barrier preventing the upward movement of oil and gas trapped in the Wytch Farm oilfield.

Older sedimentary rocks only occur in this subregion at the bottom of the depth range of interest in the vicinities of Yeovil and Melksham. They include limestones, sandstones and mudrocks, which have been buried to a depth such that they are now highly compacted compared to the younger sedimentary rocks above. Also they are located in a zone of rock deformation extending from south-west England and south Pembrokeshire east across the south of England and some of the mudstones have been folded and metamorphosed to form schist-like rocks. There is little information on the nature of these rocks at these depths and further information would be required to evaluate their potential as Higher Strength Rock (HSR) host rocks.

A summary of the geological attributes of the Hampshire Basin and adjoining 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 sedimentary rocks have been affected by faults and folding across much of the subregion (see Figure 2). Faults may act as barriers to or pathways for groundwater movement, depending upon their characteristics, and 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. A number of principal aquifers are present in this subregion including the Chalk Group, Upper Greensand Formation, Great and Inferior Oolite Groups and Bridport Sand Formation, all of which are located above the LSSR layers occurring in the depth range of interest. The thick layers of LSSR described above are likely to provide hydraulic separation between deep and shallow groundwater even where these layers are not thick enough to host a GDF. At greater depths, and away from the surface outcrop, groundwater in at least some of these aquifers has been shown to become saline due to very little mixing with surface waters. For example, groundwater in the Great Oolite Group aquifer is not potable where it is confined by the Oxford Clay Formation. Groundwater from depths greater than 400m is unlikely to be suitable as drinking water anywhere in the UK [2].

There is one very small area, near Westbury, 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

Oil and gas exploration has not identified any conventional resources in this subregion although a small area to the north-east of Dorchester has been identified as having shale gas potential. The Dorset Halite Member may be considered for gas storage in the future although a proposed storage project at Portland has been abandoned.

The Hampshire Basin has been exploited for geothermal energy (at Marchwood near Southampton). Future licensing plans for geothermal energy would be considered in the siting of a GDF in this subregion.

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 Hampshire Basin and adjoining areas subregion 1 where any of the 3 Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

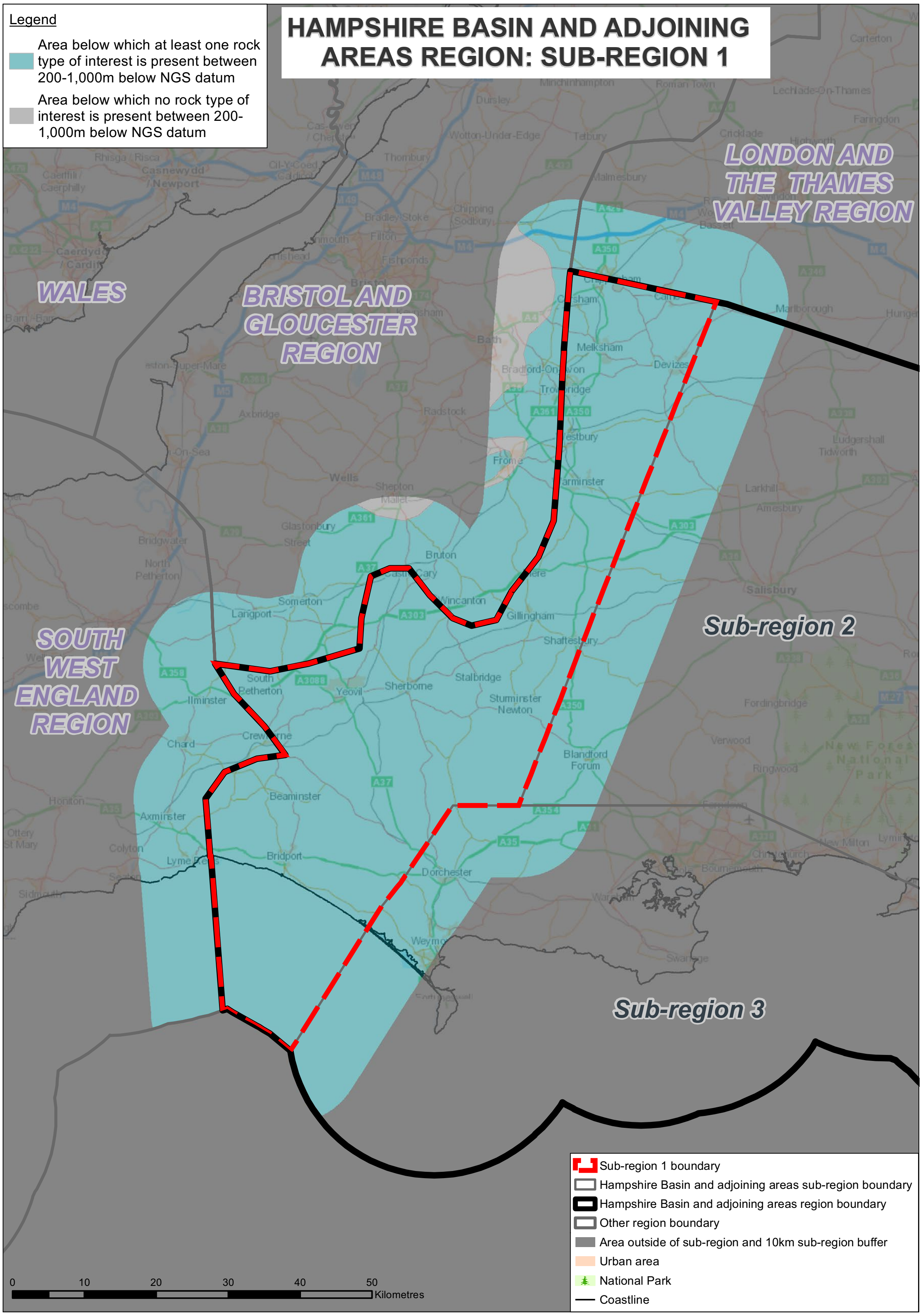


Figure 1b e areas of the Hampshire Basin and adjoining areas subregion 1 where Lower Strength Sedimentary Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

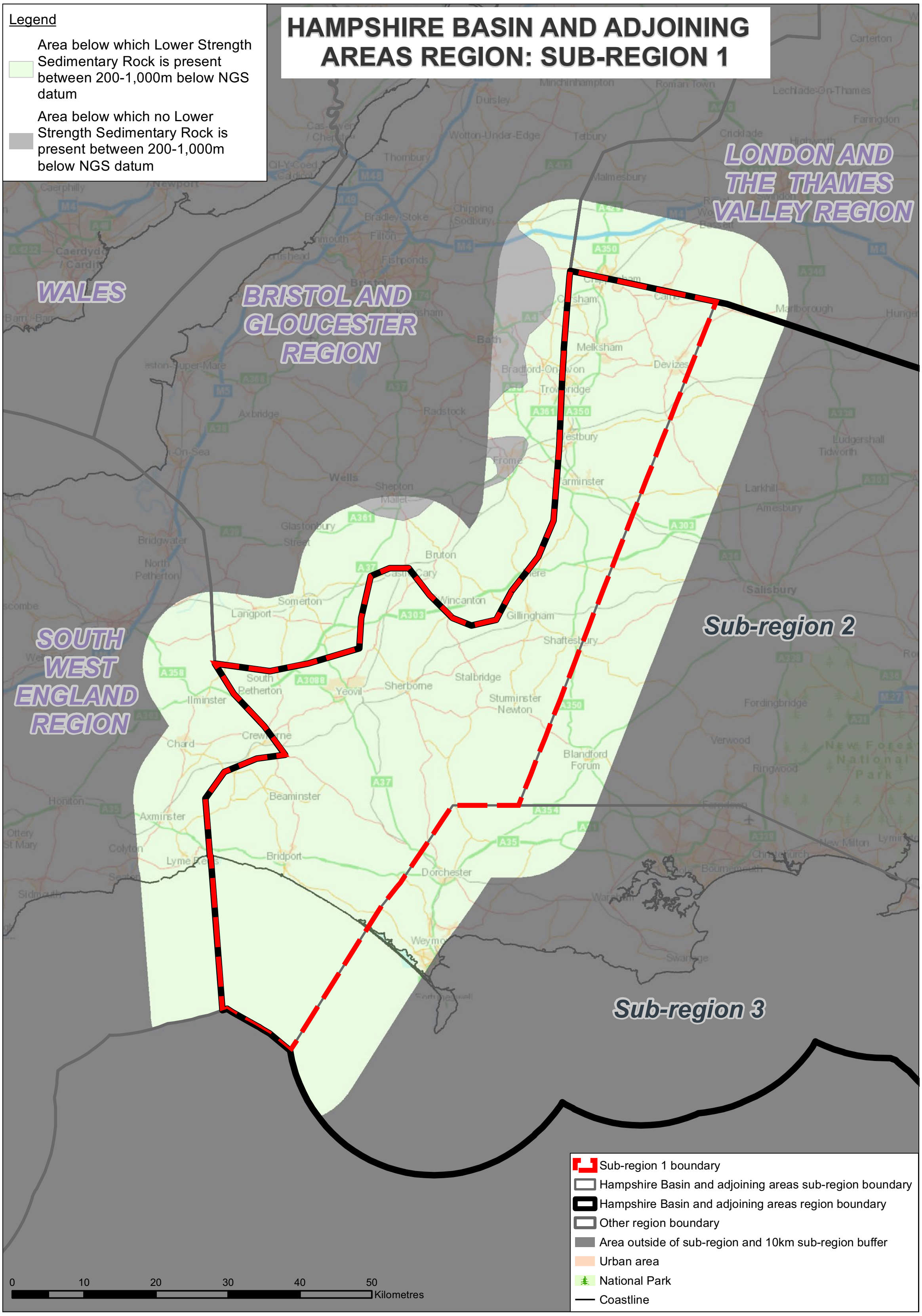


Figure 1c The areas of the Hampshire Basin and adjoining areas subregion 1 where Higher Strength Rocks of interest are present between 200 and 1,000m below NGS datum.

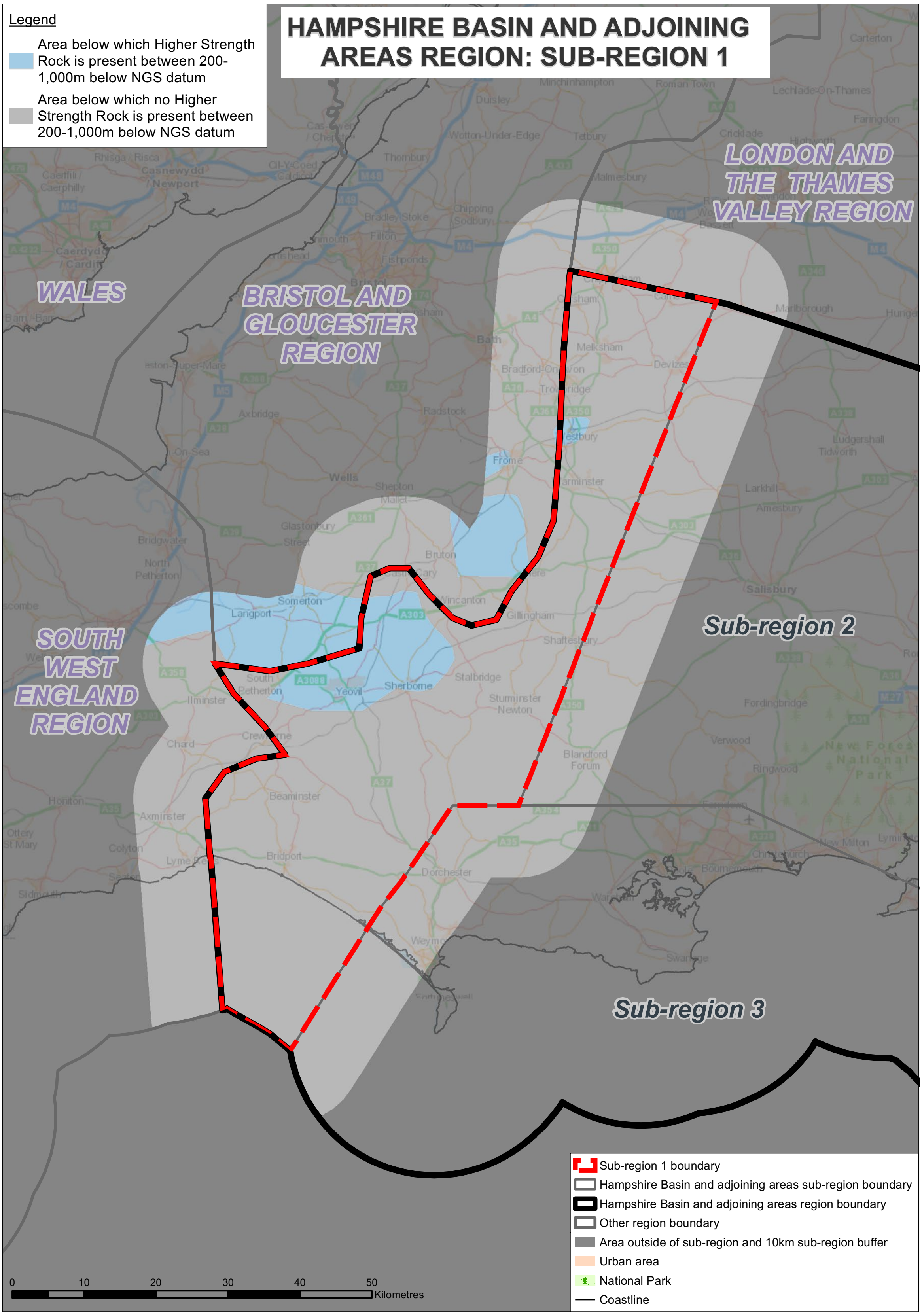


Figure 1d The areas of the Hampshire Basin and adjoining areas subregion 1 where Evaporite Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

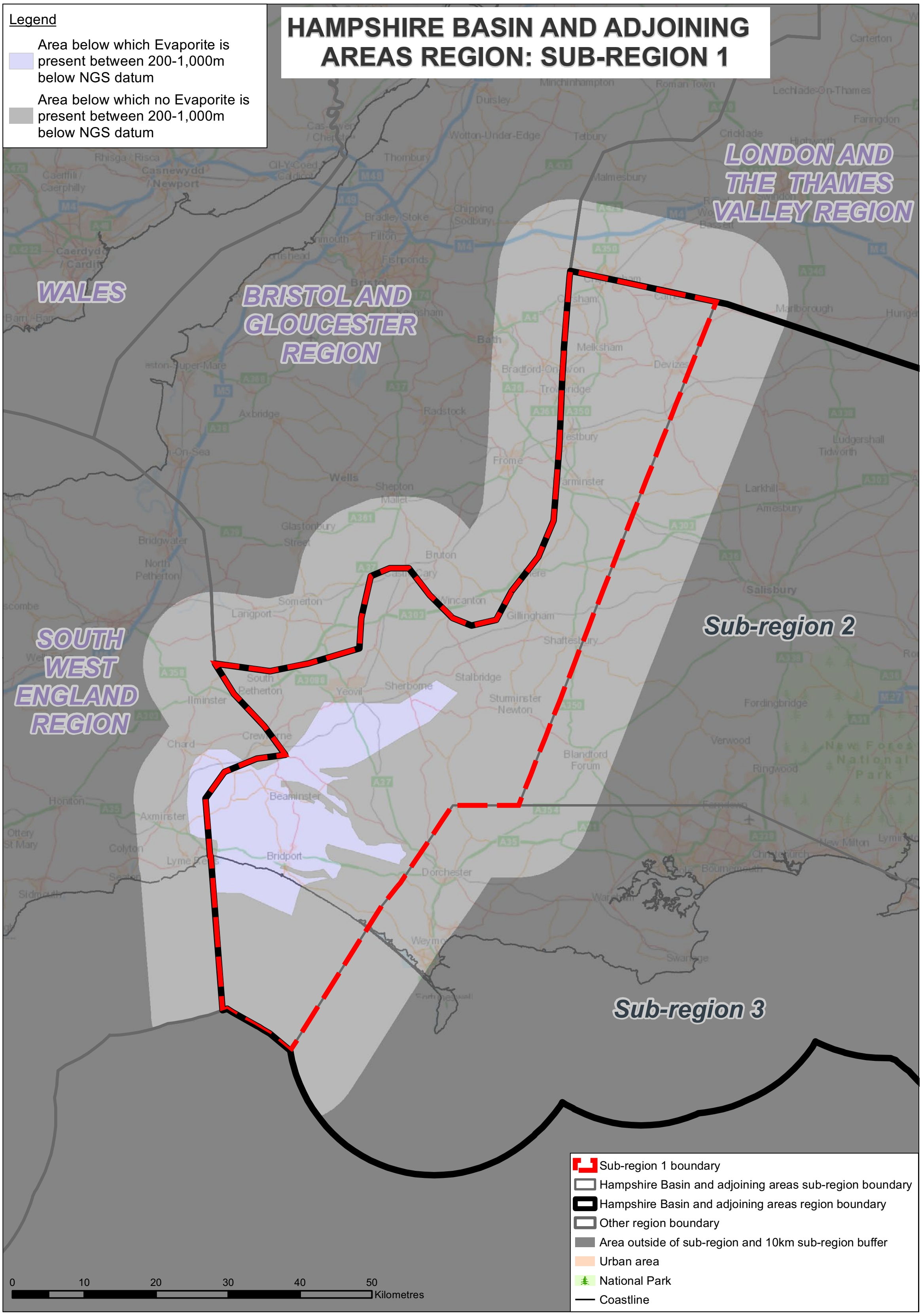


Figure 2 Location of major faults and folds in the Hampshire Basin and adjoining areas subregion 1.

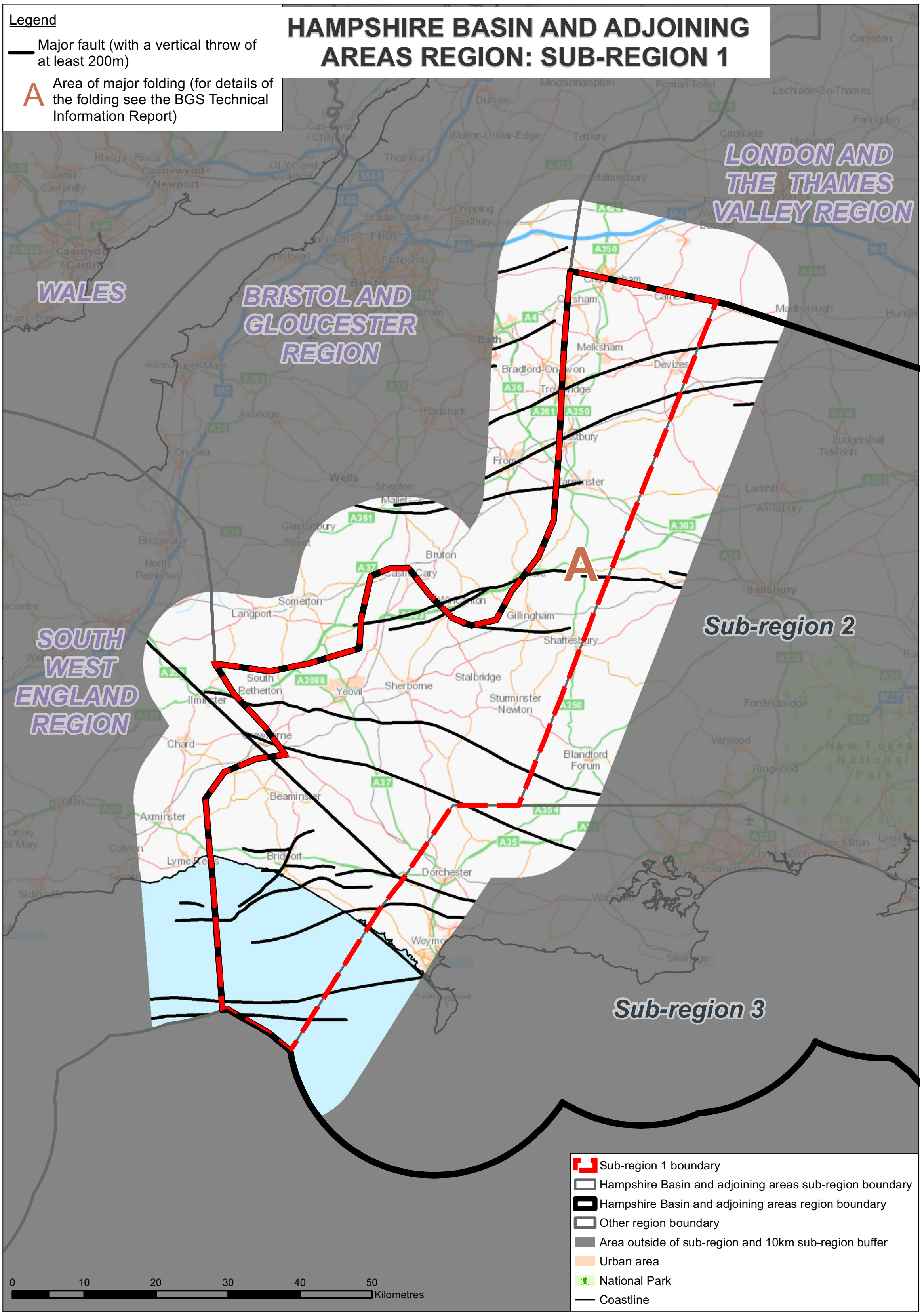
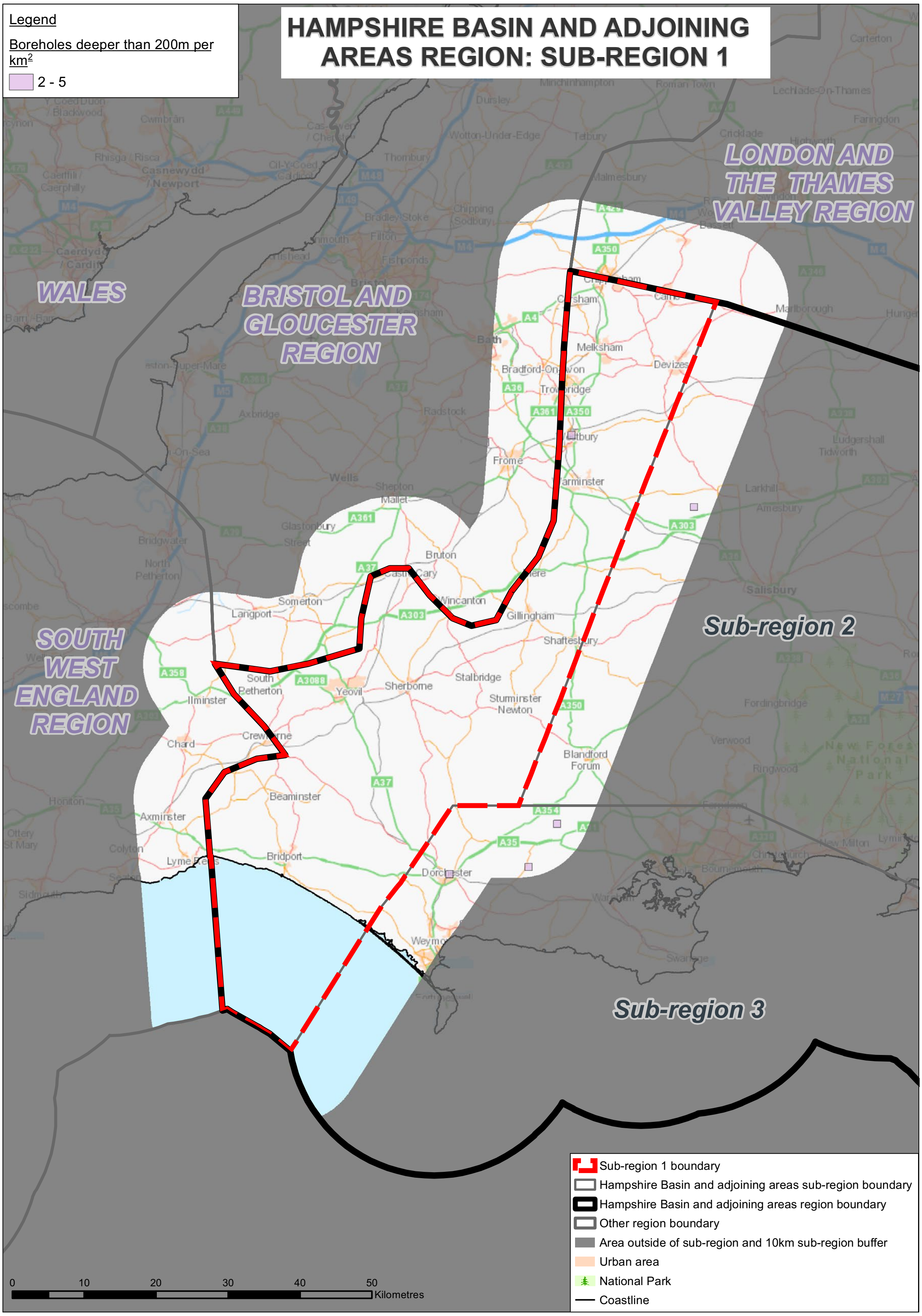


Figure 3 Areas in the Hampshire Basin and adjoining areas subregion 1 with concentrations of deep exploration boreholes.



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.

Compacted
The action of squeezing as sediments become more deeply buried. Like wringing a sponge, compaction leads to loss of pore water and reduction of pore spaces between rock grains.

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.

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.

Outcrop
A visible exposure of bedrock on the surface.

Potable
Water that is of drinkable quality.

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).

Schist
Recrystallized metamorphic rocks with a distinctive texture caused by the parallel alignment of tiny crystals of mica. As a result, schists are characteristically sheet-like, rather like the pages of a telephone directory.

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.

Shale gas
Gas that is naturally generated and trapped within shales that contain a high amount of organic material. Shale gas can be extracted for use as a fuel in heating or power generation by a technique known as hydraulic fracturing or 'fracking'.

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

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