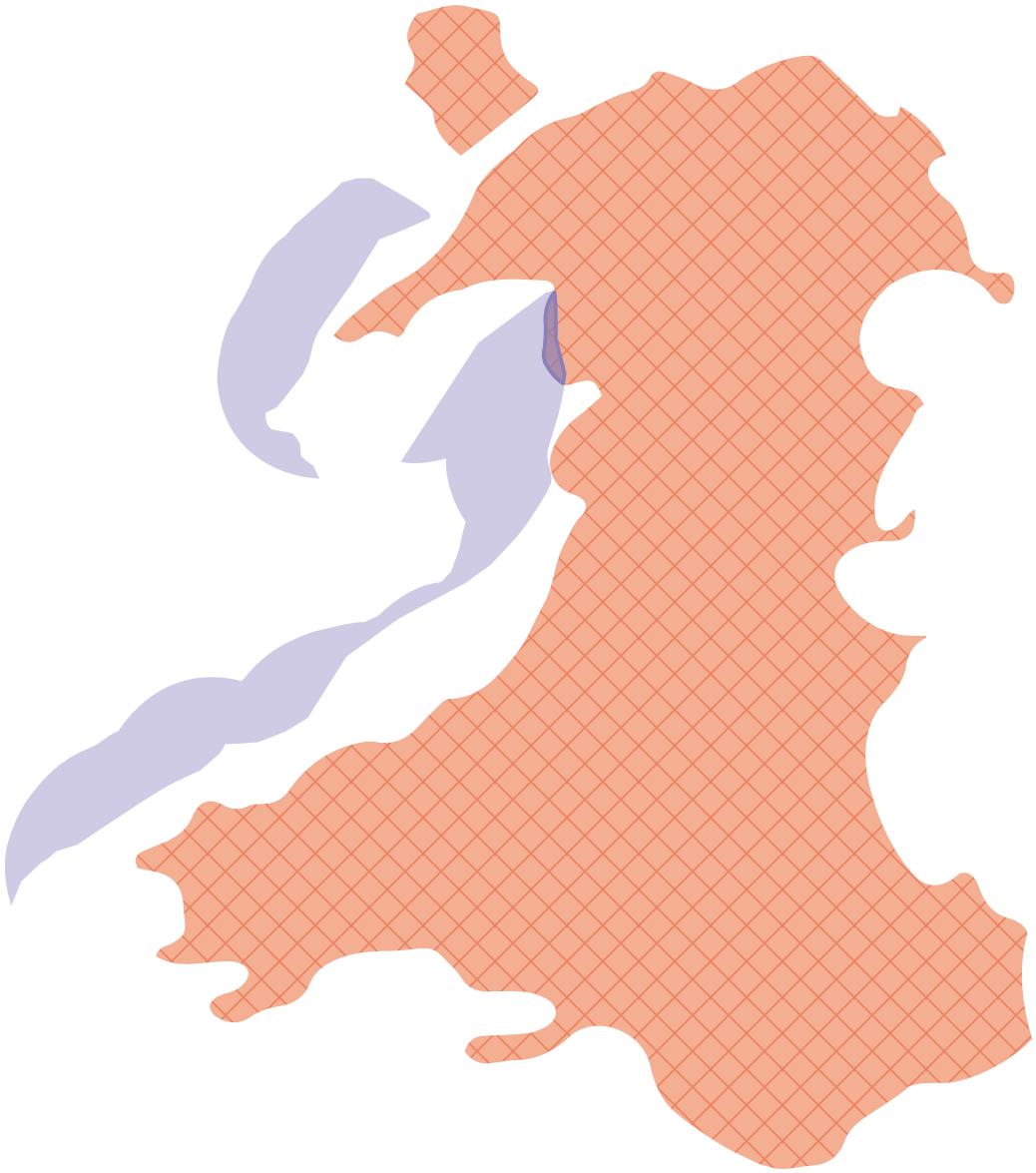
Radioactive Waste Management



Wales

SUBREGION 6

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.

Given that most of this subregion is the inshore which extends to 20km from the coast, no rock can be seen at the surface but a small number of boreholes and geophysical investigations give us an understanding of the geology at depth.

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 to the west of the Llŷn peninsula 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.

Two parts of the subregion, to the north and west of St Davids and to the south-west of the Llŷn Peninsula, 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.

Introduction

The Cardigan Bay and St George's Channel subregion extends from St Davids Head to Caernarfon Bay and is entirely off the coast in the inshore which extends to 20km form the coast, except for a small area south of Harlech.

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) of interest in this subregion are part of the younger sedimentary cover. They comprise Miocene to Eocene sedimentary rocks (approx. 5 to 55 million years old) overlying Jurassic to Permian rocks (approx. 145 to 300 million years old) which are known only from boreholes and seismic surveys. In Cardigan Bay the Miocene to Eocene rocks extend to around 600m below the seabed in the Mochras borehole, on the coast near Harlech; even thicker sequences are present off the coast in St George's Channel. While they contain some mudstones, which are likely to act as barriers to upwards movement of water, they are dominated by sandstones, conglomerates and siltstones.

Beneath the Eocene rocks there is a break in the sedimentary rock sequence and the underlying Jurassic rocks are considerably older. In the Mochras borehole, the Jurassic is represented by Lias Group rocks which are 1,305m thick, but elsewhere in the subregion Upper and Middle Jurassic rocks are present and include significant thicknesses of clay-rich rocks including the Kimmeridge Clay, the Ampthill Clay and the Middle Jurassic Ancholme Group. These Middle and Upper Jurassic mudstones are likely to contain thick units which are potential LSSR host rocks and also provide a barrier to the movement of groundwater.

The Lias Group comprises mudstones and calcareous mudstones, often alternating with siltstones. In Cardigan Bay, the Lias Group is likely to contain thick mudstones suitable to host a GDF, and provides an effective barrier to movement of groundwater from depth towards the surface even where it is not thick enough to host a GDF. However, in some parts of the subregion it may be too deep to be of interest.

The Mercia Mudstone Group occurs beneath the Jurassic rocks and is within the depth range of interest in some parts of the subregion, but is not very well known. In Cardigan Bay it is probably present below the depth of deep drilling, but it has been drilled in St George's Channel. Several distinct units are recognised and include evaporite deposits as well as mudstone, siltstone, dolomitic limestone and some sandstone. Mudstones in the Mercia Mudstone Group are potential LSSR host rocks.

In the north of the subregion, the Cumbrian Coast Group occurs beneath the Mercia Mudstone Group and includes evaporite units with significant thicknesses of rock salt (halite) which are potentially suitable as Evaporite host rocks if they prove to be sufficiently thick and pure.

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 are also small volumes of potential Higher Strength Rocks below the younger LSSR rocks within this subregion to the south-east and south-west of the Llŷn Peninsula.

A summary of the geological attributes of Wales 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 younger sedimentary rocks in this subregion are affected by only a small number of major faults which largely controlled the formation of the basins in which the sediments were deposited (Figure 2). There is also no evidence for major folding in these inshore basins. However given that this subregion is located mostly inshore, the level of detail with which it is possible to map major structures is significantly less than onshore and we would need to carry out a more detailed investigation as part of site evaluation. 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. There are permeable rocks present at depth in this subregion. In some other regions these rocks occur onshore at shallow depths and are principal aquifers. In this subregion they are only present off the coast where the water present in the pores of rocks beneath the seabed is saltwater rather than fresh and they are not therefore suitable for use as aquifers.

There is no information about deep groundwater behaviour in this subregion, but it is likely that the numerous LSSR layers in this subregion separate the deep groundwater from the seabed, even where they are not thick enough to host a GDF.

There are no concentrations of deep exploration boreholes in this subregion or thermal springs 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.

Resources

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

There are two parts of the subregion with Oil and Gas Authority licenses, to the north and west of St Davids and to the south-west of the Llŷn Peninsula (Figure 3), allowing companies to explore for these resources. It is not known whether 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.

Figure 1a The areas of Wales subregion 6 where any of the 3 Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

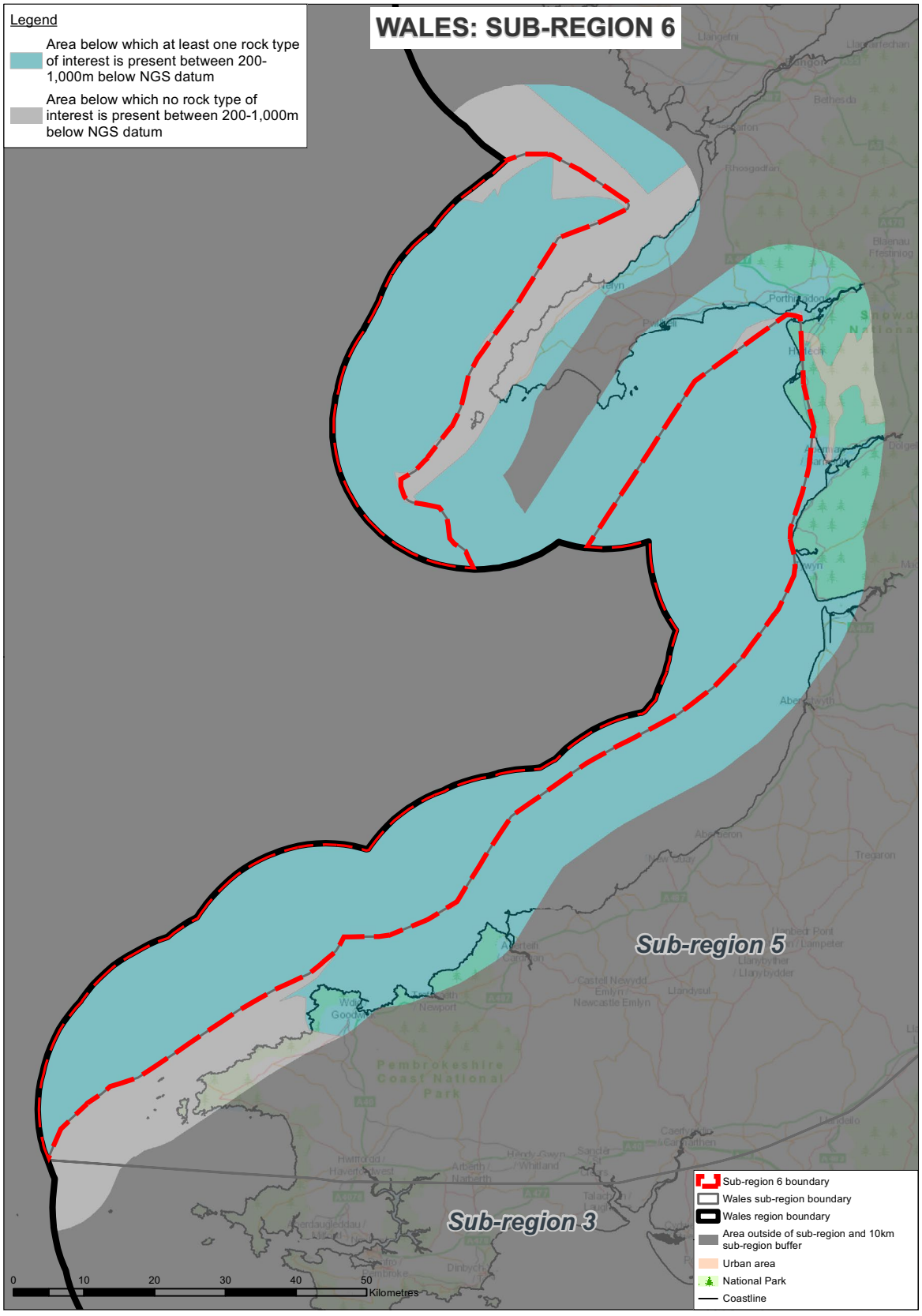


Figure 1b The areas of Wales subregion 6 where Lower Strength Sedimentary Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

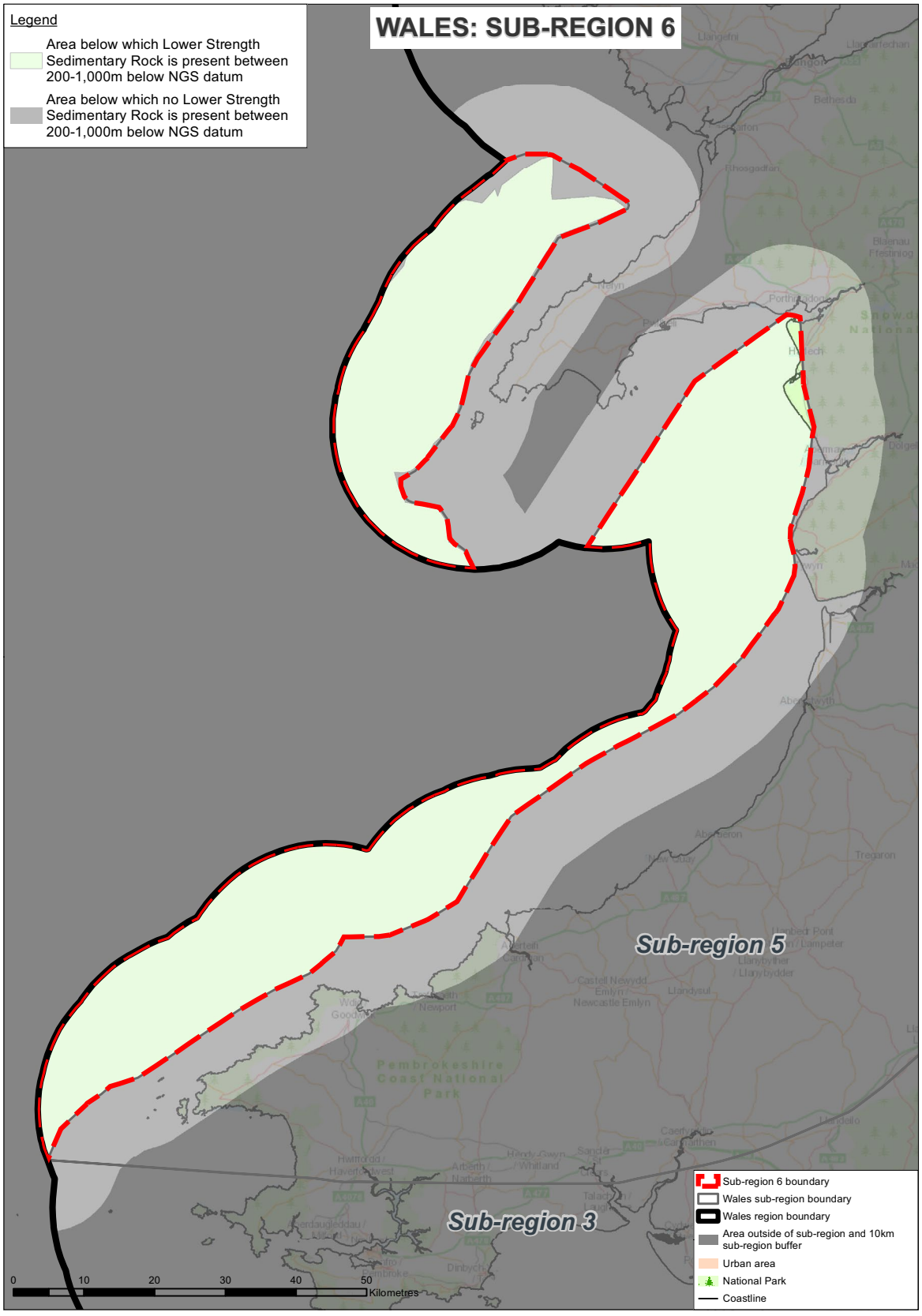


Figure 1c The areas of Wales subregion 6 where Higher Strength Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

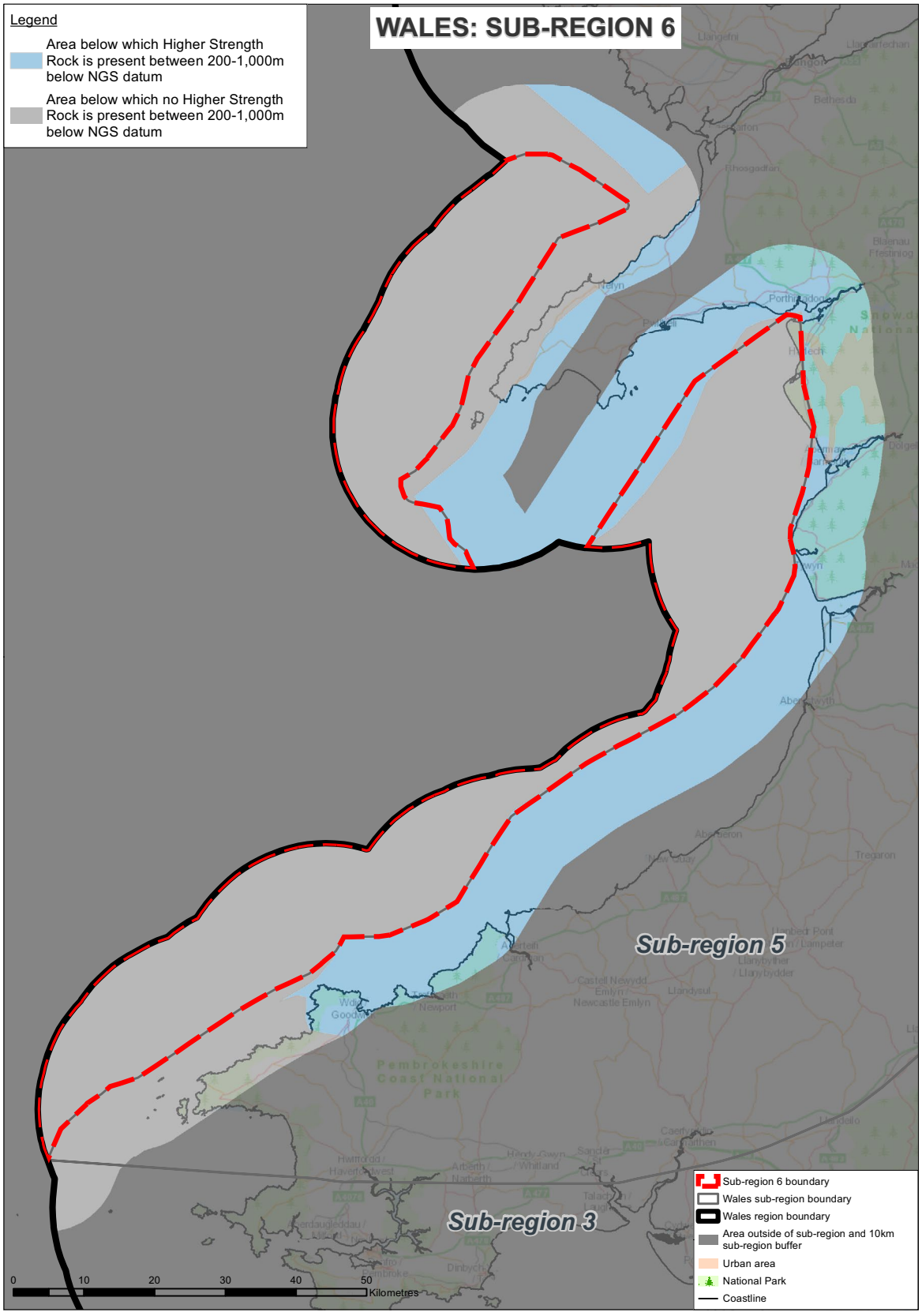


Figure 1d The areas of Wales subregion 6 where Evaporite Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

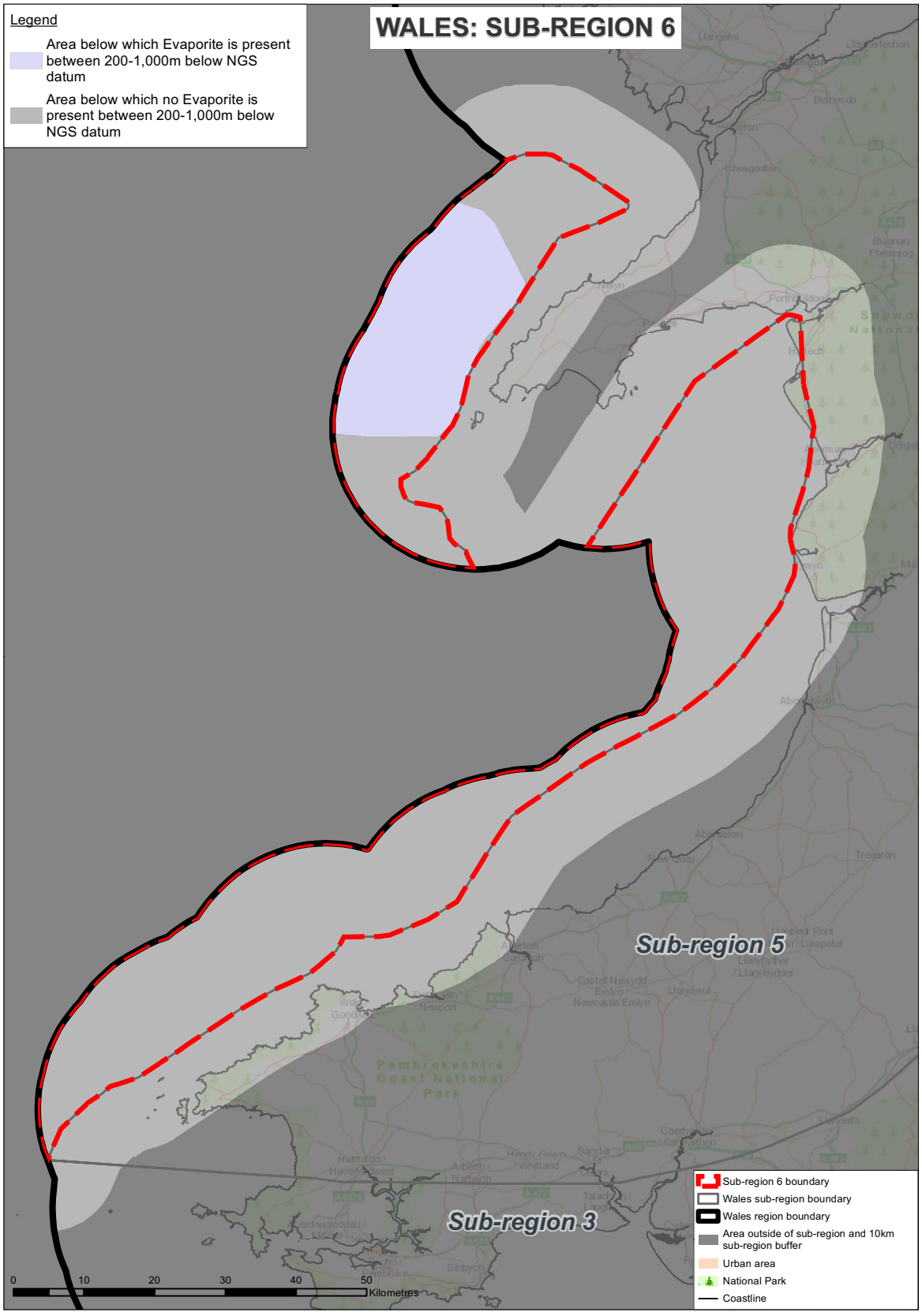


Figure 2 Major faults and areas of folding in Wales subregion 6.

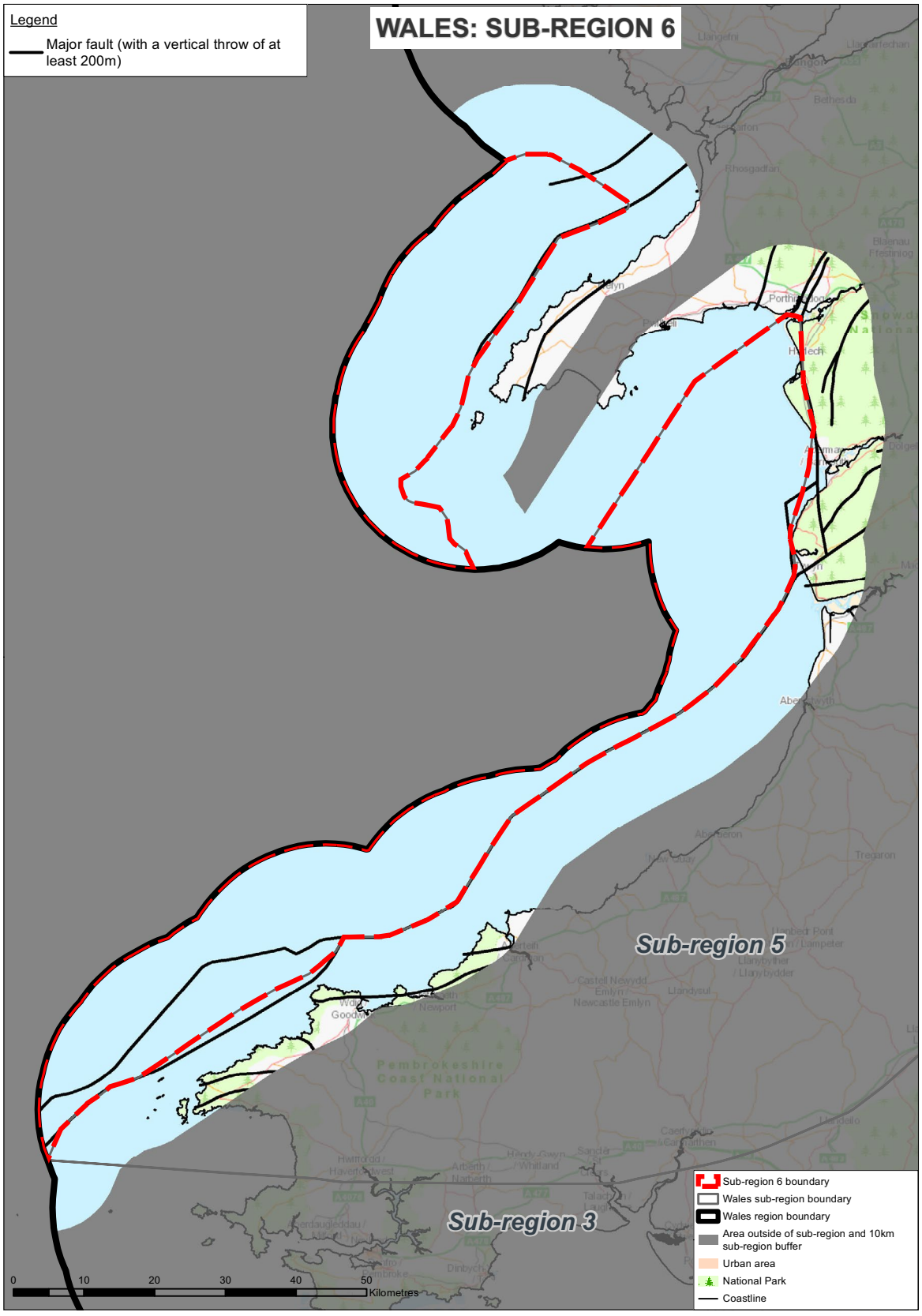
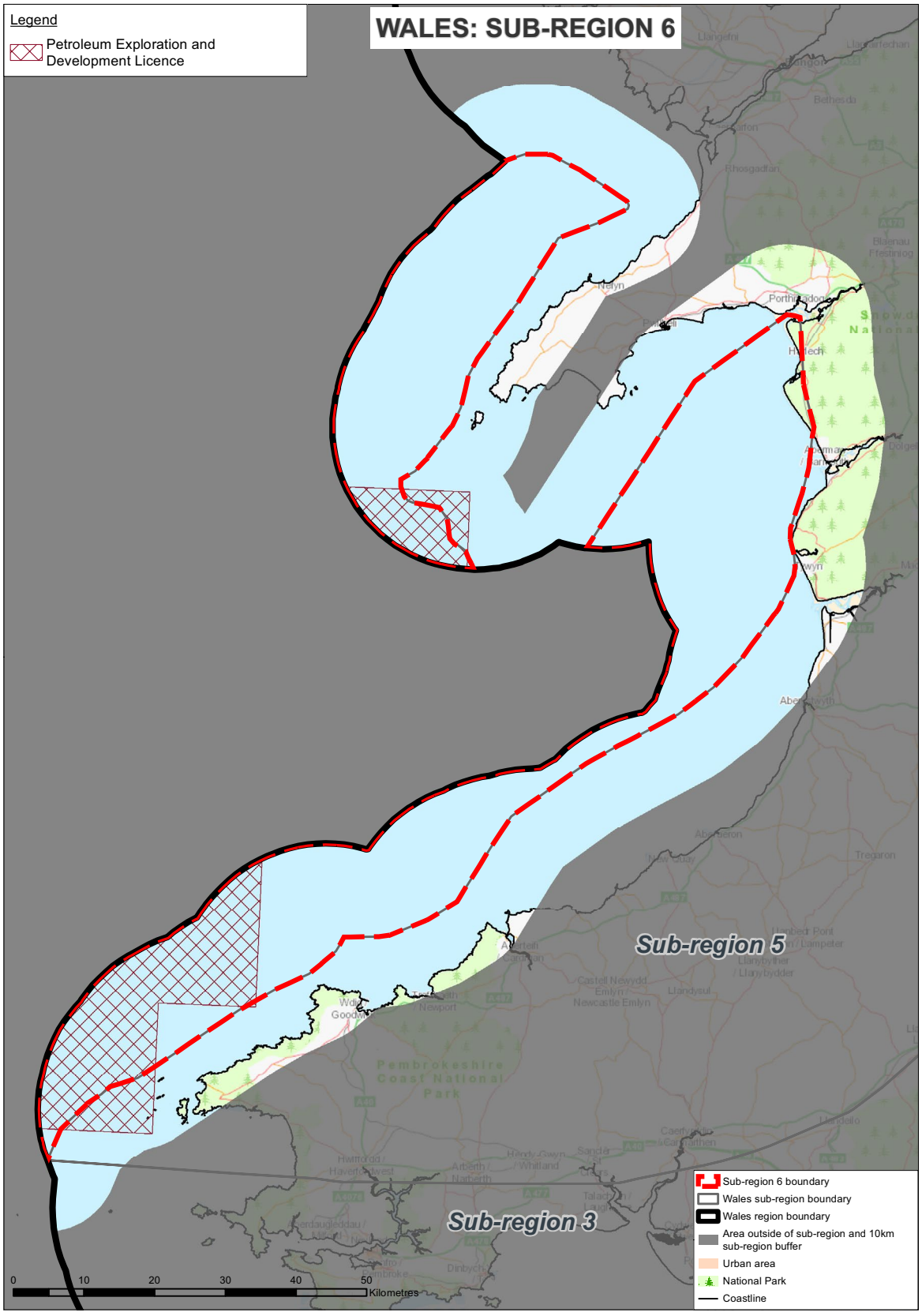


Figure 3 Areas of Wales subregion 6 with Petroleum Exploration and Development Licences.



Glossary

Aquifer
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.

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'.

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.

Sediment
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).

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.

Seismic survey
Geophysical method that produces an image of the subsurface by transmitting shock waves, or seismic energy, into the ground and measuring the pattern of energy that is reflected back to the surface. Widely used by the resource industries to provide information on the composition and structure of the underground geology.

Radioactive Waste Management

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