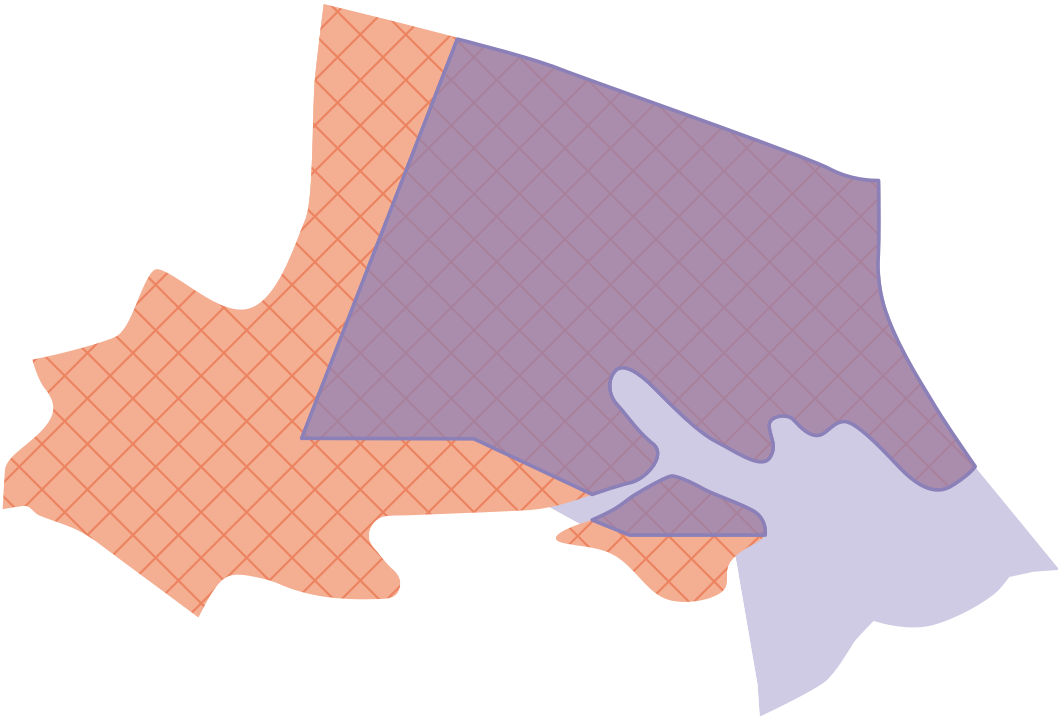
Radioactive Waste Management



Hampshire Basin

SUBREGION 2

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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 be able to find a suitable geological setting for a GDF in most of this subregion.

Rock can be seen at the surface in some parts of the subregion such as the sea cliffs of the Isle of Wight and man-made excavations such as quarries or road cuttings. Combined with numerous 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. 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.

Some of the subregion, near Andover, Winchester, Alton and Horndean, has known oil resources. In these areas the drilling 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 this area, in the east of the subregion, 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

This subregion comprises the largest part of the Hampshire Basin and adjoining areas region east of a line through Dorchester, Shaftesbury and Devizes, north of a line through Bere Regis, Poole and Christchurch and incorporating the north-eastern half of the Isle of Wight. It includes the adjacent inshore area extending to 20km from the coast to the east of the Isle of Wight.

Rock type

Figure 1 shows where in the subregion there are likely to be Lower Strength Sedimentary Rocks (LSSR) within the depth range of interest. The rocks in the depth range of interest in this subregion comprise a well-known sequence of younger sedimentary rocks, overlying older sedimentary and basement rocks which occur only below the depth range of interest. The depth range of interest contains a number of LSSR layers which are all in excess of 50m thick over part of the subregion and comprise extensive, uniform clay-rich layers. These include the following Rock Types of Interest:

- The Gault Clay Formation is present in the depth range of interest under the whole subregion attaining thicknesses greater than 50m in the north of the subregion.
- The Wealden Group occurs in the depth range of interest under the Hampshire Downs and South Downs north-east of Salisbury and Southampton, and in the southern part of the Isle of Wight. It ranges up to 500m thick in the northern Hampshire region and 580m thick on the Isle of Wight.
- The Kimmeridge Clay Formation is 200 to 250m thick within the depth range of interest over much of the northern half of the subregion. It was entirely removed along an axis extending from Dorchester towards Lymington and is absent beneath an unconformity over large parts of the south of the subregion.
- The Oxford Clay Formation is within the depth range of interest in a broad, north-south trending belt that extends from Swanage to Devizes and lies to the west of Southampton and to the east of Warminster. It maintains a fairly uniform thickness of around 100 to 150m across much of the subregion.

The mudstone dominated lower and middle Lias Group (a part of which occurs in the cliffs at Lyme Regis and Charmouth as the famous 'Blue Lias' Formation) also occurs toward the base of the depth range of interest in a north-south trending area to the west of Fordingbridge. These rocks are mostly less than 200m thick across the subregion and contain numerous limestone layers. As a result it is unlikely that individual mudstones are thick enough to act as a host rock, but the Lias Group provides an effective barrier to groundwater movement from depth towards the surface.

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, particularly in the east of the subregion, the constructability of a GDF would be considered during the siting process.

In addition to the thicker mudstones in this sedimentary sequence, there are a number of other mudstone layers in the Solent, Bracklesham, Bagshot, Thames, Lambeth, Corallian and Great Oolite Groups. Although these rocks may not be thick enough to host a GDF, they are likely to provide hydraulic separation between shallow and deep groundwater.

The BGS have identified a small volume of pre-Permian basement rocks off the coast from Selsey Bill, which are potential Higher Strength Rocks, however there is very little information about the precise depth, lithology or properties of these 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 distributions of potential LSSR host rocks in this subregion are affected by the 4 main structural zones of folding and faulting aligned in an east-west direction (see Figure 2). These fault zones were active during the deposition of Jurassic and Cretaceous sediments (approx. 65 to 200 million years ago) and therefore influence the local thickness variations of many of the LSSR layers.

The faulted and folded zones may influence groundwater movement, particularly where steeply dipping and near-vertical layers are associated with intensely developed fracture zones, such as in the Sandown and Abbotsbury monoclines. Note that 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].

[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. The Chalk Group is widely used as a principal aquifer across the whole subregion with borehole abstractions focused in valley bottoms where fractures result in the highest permeabilities. The Chalk Group also exhibits karstic features, such as to the east of Dorchester, where concentrated flow of mildly acidic groundwater has enlarged fractures by dissolution to form a network of major fissures, resulting in fast movement of groundwater near the surface. The Upper and Lower Greensand, Portland Stone, Great and Inferior Oolite Group and Bridport Sand Formations and aquifers are also present, although they are too deep for groundwater abstraction over much of the subregion. The Sherwood Sandstone Group, which is a principal aquifer in other regions where it occurs at shallow depths, also occurs below this subregion but is too deep to be exploited as an aquifer. Groundwater from depths greater than 400m is unlikely to be suitable as drinking water anywhere in the UK [2]. The numerous LSSR layers in this subregion are likely to act as barriers to vertical flow between the various more permeable units described here and deep and shallow groundwater, even where they are not thick enough to host a GDF.

There are some areas, such as around Winchester and Horndean, 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.

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

Resources

There are several onshore oil fields in the subregion near Andover, Winchester, Alton and Horndean (Figure 4). Oil is being extracted from Humbly Grove, Stockbridge Herriard, Goodworth Hill Farm, Folly Farm and Horndean. In these areas the drilling 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.

In addition, Petroleum Exploration and Development Licences [3] for the Wealden Basin to the east of this region also extend into this subregion in an area to the north of Petersfield (see Figure 4). These include areas containing mudstones or shales which have been identified as having potential for shale oil and/or shale gas. One of these licences, in the vicinity of the Humbly Grove field extends into the adjacent London and Thames Valley region between Basingstoke and Farnham. 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.

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.

[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 Hampshire Basin and adjoining areas subregion 2 where Lower Strength Sedimentary Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

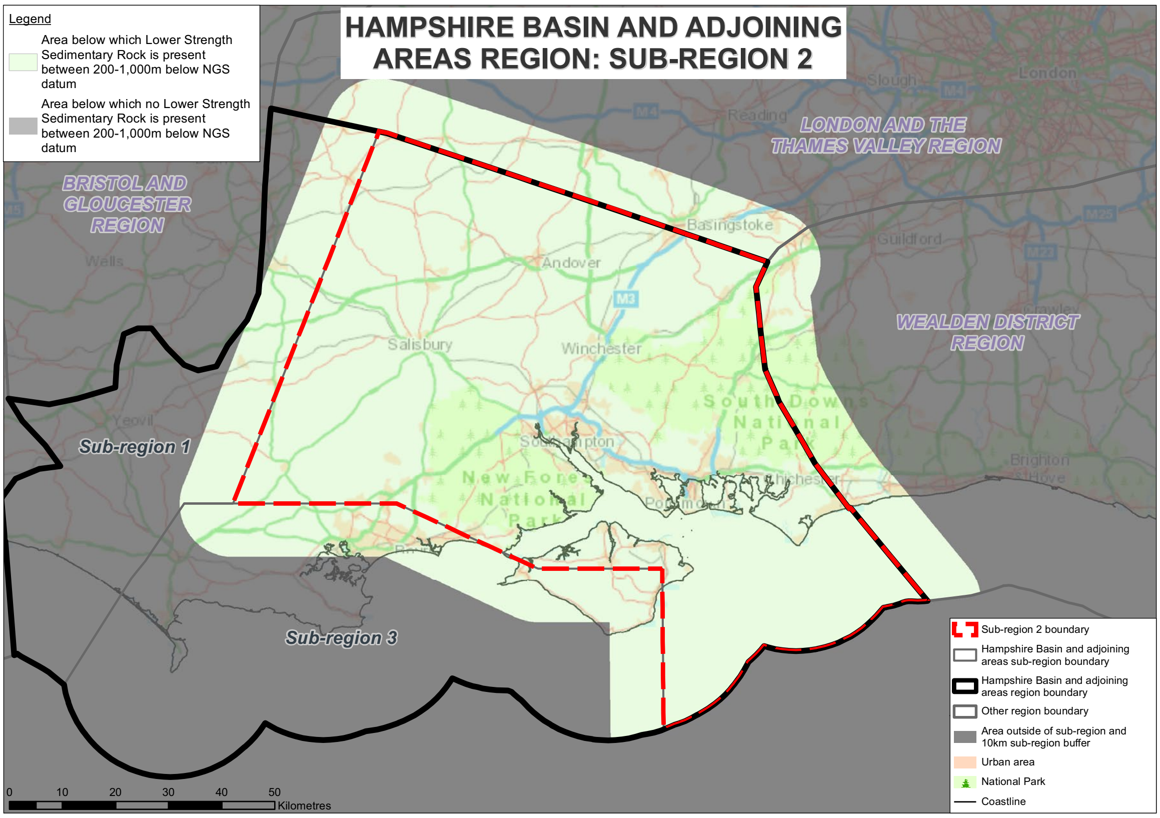


Figure 2 Location of major faults and folds in the Hampshire Basin and adjoining areas subregion 2.

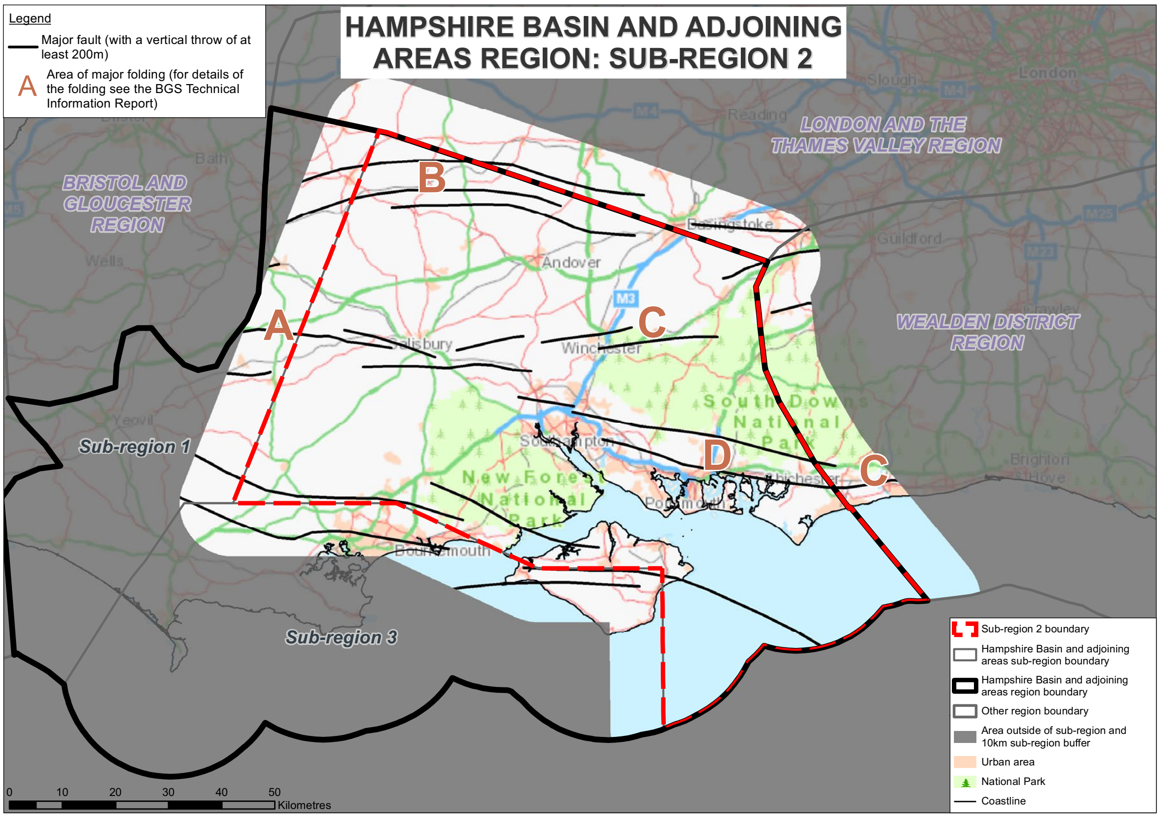


Figure 3 Areas in the Hampshire Basin and adjoining areas subregion 2 with concentrations of deep exploration boreholes.

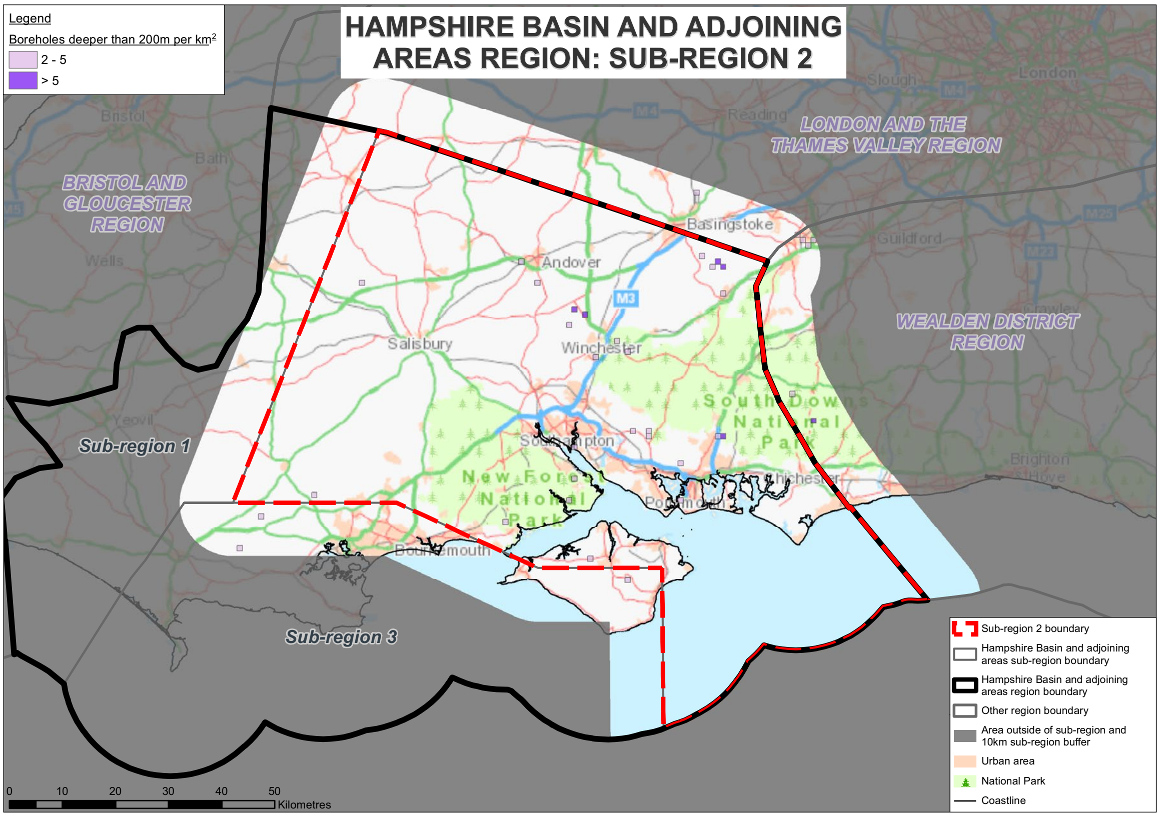
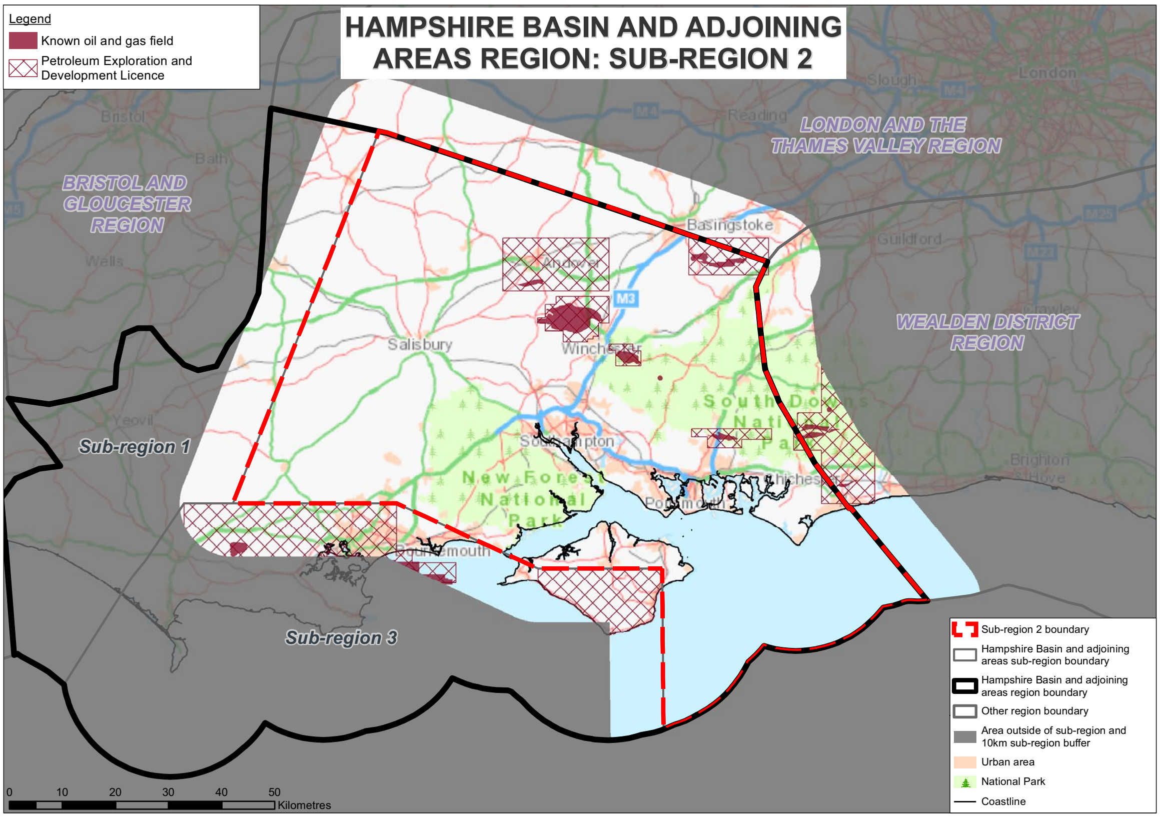


Figure 4 Areas of the Hampshire Basin and adjoining areas subregion 2 with oil and gas fields and Petroleum Exploration and Development Licences.



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.

Fault
A fracture in the earth's crust across which the rock layers each side of it have been offset relative to one another.

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

Fracture zone
A region of closely spaced cracks or faults in a volume of rock. Fracture zones may provide a pathway for fluids to move underground in rocks that would otherwise be impermeable.

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.

Lithology
The physical properties of rock types.

Monocline
Step-shaped fold in layered rock strata.

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.

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.

Shales
A very fine-grained and strongly layered sedimentary rock in which the grains are not visible to the naked eye. Consists of clay grains and tiny fragments of other minerals such as quartz and mica.

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'.

Shale oil
Oil that is naturally generated and trapped within shales that contain a high amount of organic material . Shale oil can be extracted by a technique known as hyrdaulic fracturing or 'fracking' and used as a fuel in heating or power generation, or refined into petroleum products.

Radioactive Waste Management

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