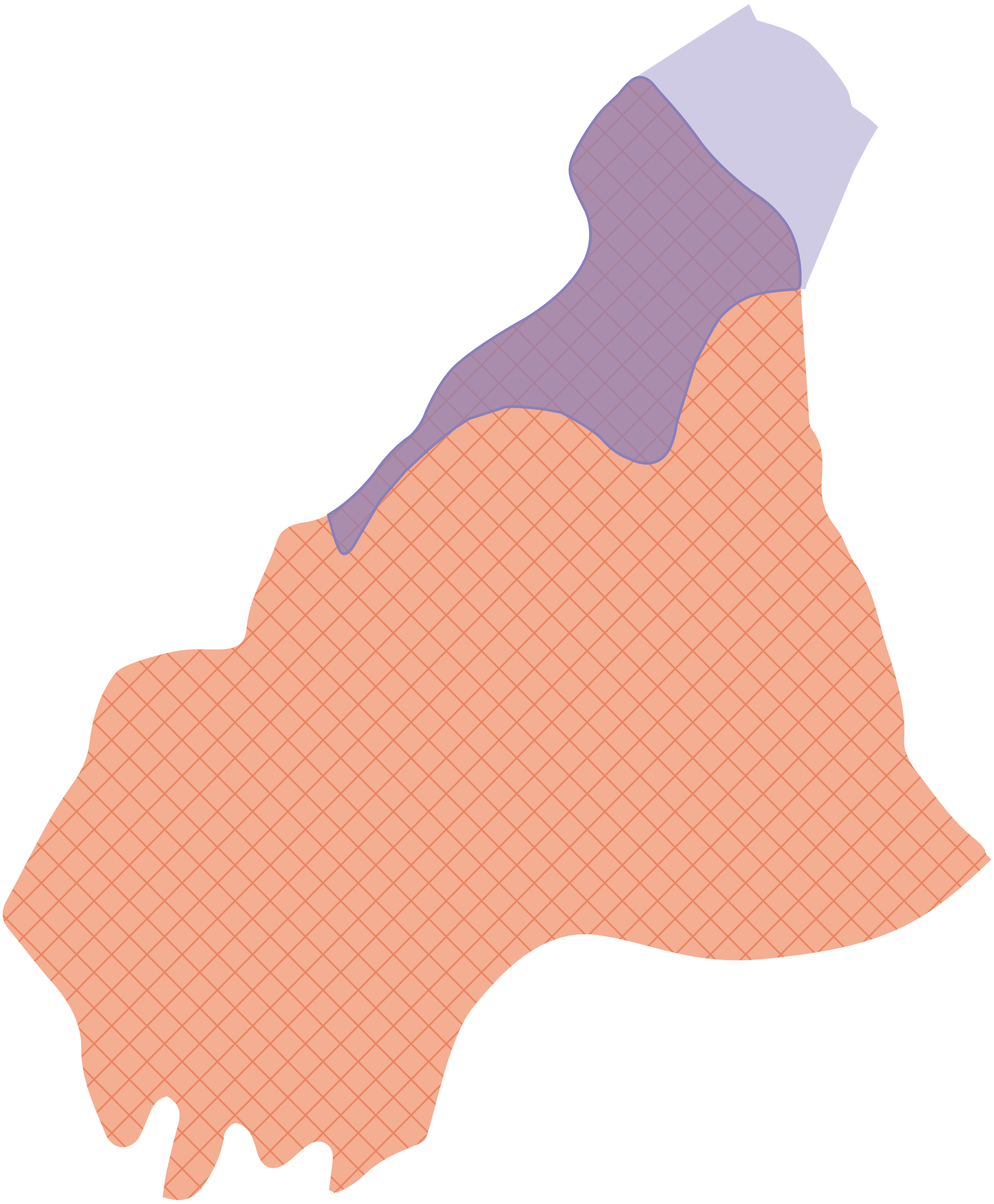
Radioactive Waste Management



Northern England

SUBREGION 1

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.

Rock can be seen at the surface at some places in this subregion such as the sea cliffs in the east, inland cliffs in the Cheviot Hills and in 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 granites, volcanic lavas and similar strong rocks under most of the 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.

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 Cheviot Hills and surrounding areas extending north from near Alnwick, and is bounded to the north by the Scottish border. It includes the adjacent inshore area which extends to 20km from the coast.

Rock type

Figure 1 shows where in the subregion there are likely to be Higher Strength Rocks (HSR) within the depth range of interest, there are no Lower Strength Sedimentary Rocks (LSSR) or Evaporites in the subregion. There are 2 main types of rock with potential to act as HSR host rocks:

- The Inverclyde Group rocks of Carboniferous age (approx. 300 to 360 million years old) are present from the Solway to the Cheviots. They comprise lava flows of basalt interbedded with sedimentary rocks and occasional layers of volcanic ash deposits (tuff). The volcanic layers are known to range up to 150m in thickness and are therefore potential HSR host rocks, but their distribution in the depth range of interest is not well known.
- The Cheviot Volcanic Formation of Devonian age (approx. 360 to 420 million years old) comprises a thick suite of volcanic rocks which form the Cheviot Hills. It comprises a sequence of lavas, mainly of andesite, and the Cheviot granite which intruded into them. This granite is also a potential HSR host rock, although in parts the rock is quite strongly weathered and may be too permeable to be suitable.

A summary of the geological attributes of the Northern England 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

There are a number of major faults and some major folding in this subregion (Figure 2). The southern margin of the Cheviot block is largely controlled by faults, which juxtapose Devonian volcanic rocks and intrusive granite to the north against thick sequences of Carboniferous sediments to the south. 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].

Near the coast to the east of the Cheviots, Carboniferous sedimentary and igneous rocks are affected by folding associated with faults aligned approximately north-south.

[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. A number of principal aquifers are present within 400m of the surface in this subregion which are used for public water supply, including a range of Carboniferous rocks.

The basement rocks do not normally provide a water source except where intensely fractured and weathered near the surface and there is little or no information about the hydrogeological properties of potential host rocks at depth. There are no clay-rich rock layers overlying the basement rocks in this subregion to provide hydraulic separation between deep and shallow groundwater. Groundwater from depths greater than 400m is unlikely to be suitable as drinking water anywhere in the UK[2].

There are no concentrations of deep exploration boreholes in this subregion and there are no thermal springs in this subregion to suggest rapid flow of deep groundwater to the surface.

Resources

There are no significant historic mines in this subregion and it lies outside the area of hydrocarbon licences off the Northumberland coast. The likelihood of future human intrusion in the future is therefore considered to be low.

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.

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

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

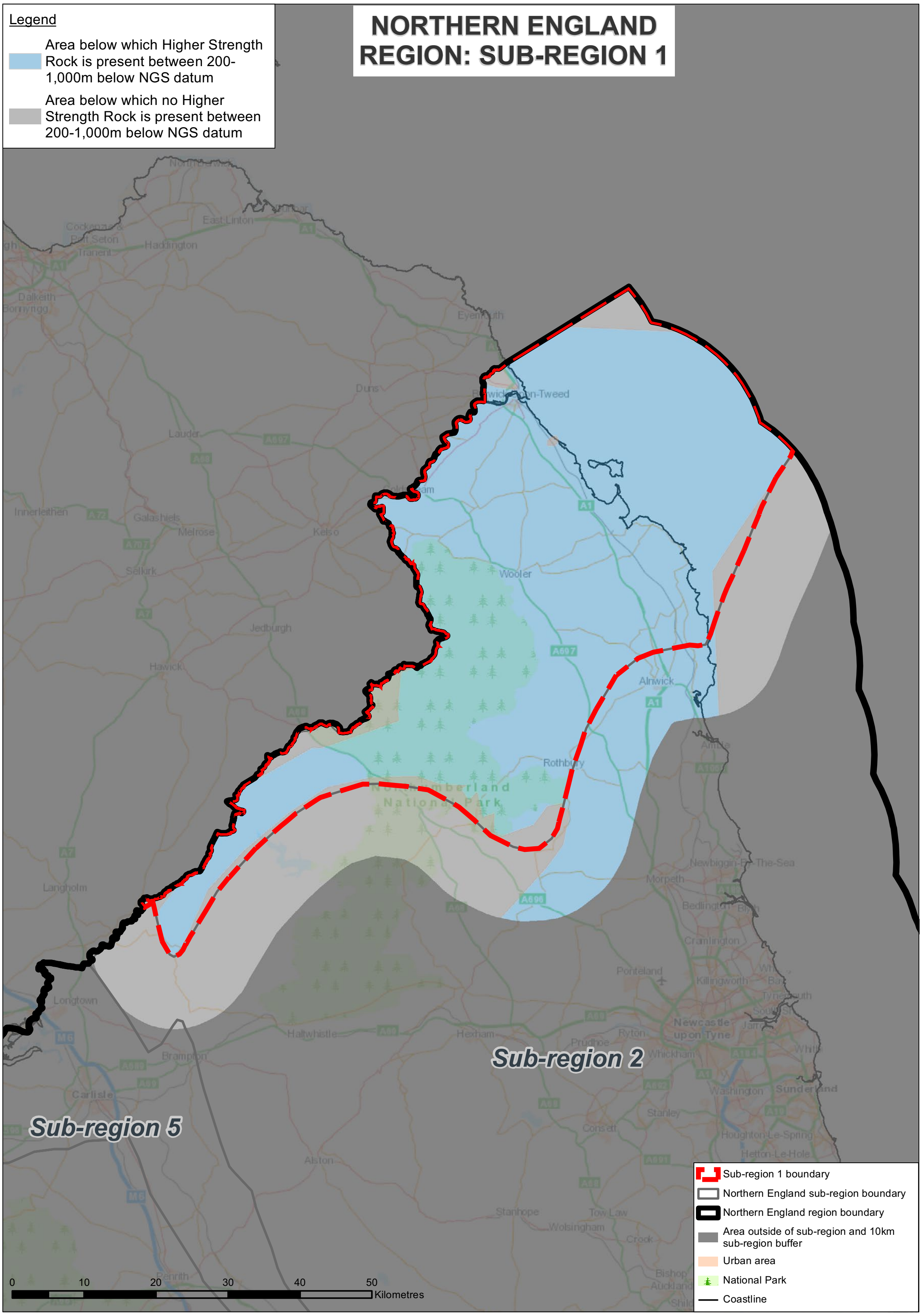
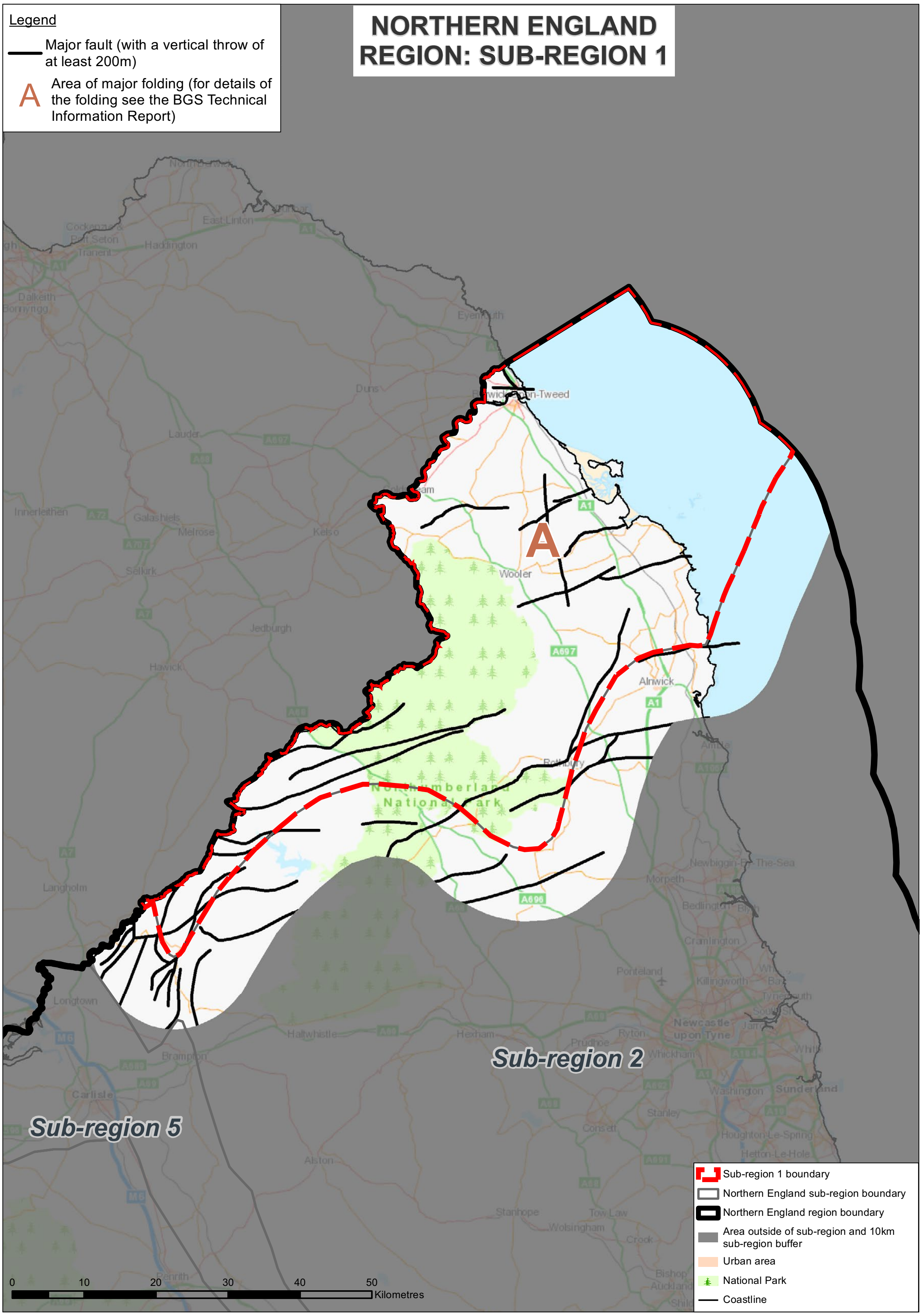


Figure 2 Major faulting and folding in the Northern England subregion 1.



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.

Basalt
Dense, dark-coloured lava rich in iron and magnesium. Forms during non-explosive eruptions of shield volcanoes, often in oceanic islands such as Hawaii.

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.

Granite
Pale-coloured, coarse crystalline igneous rock rich in silica, sodium, calcium and potassium.

Hydrocarbon
A compound of hydrogen and carbon. Hydrocarbons are the chief components of oil and natural gas.

Igneous
One of three main rock types (the others being sedimentary and metamorphic), consisting of hard, dense rocks made up of interlocking crystals. They form due to cooling of magma deep within the crust beneath volcanoes, or as lavas erupted at the surface.

Lava flow
A mass of flowing or solidified lava. After cooling and solidification, lava flows often form distinctive topographical features.

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.

Tuff
Fine-grained rock formed from compacted ash ejected during explosive volcanic eruptions.

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