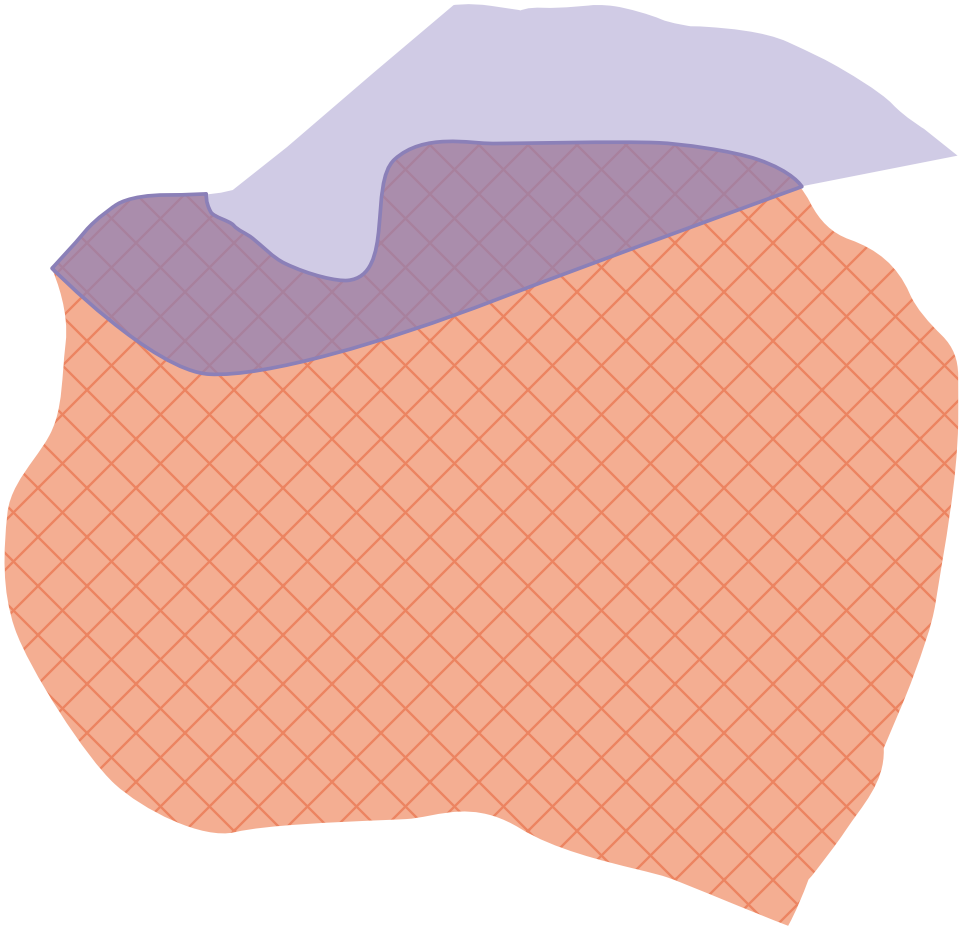
Radioactive Waste Management



East Anglia

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 only be seen at the surface in the sea cliffs from Hunstanton eastwards 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 clay-rich rock layers under the whole subregion in which we may be able to site a GDF. Geophysical investigations have indicated that there are also likely to be granites and similar strong rocks, in which we may be able to site a GDF, around Fakenham, south-west of Hunstanton, between Holbeach and Wisbech and south of Boston. 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 northern coastal part of East Anglia including The Wash, north Norfolk and the adjacent inshore area which extends to 20km from the coast.

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 a number of Lower Strength Sedimentary Rock (LSSR) units present including the Kimmeridge and Oxford Clay Formations and the Lias and Mercia Mudstone Groups. Deep boreholes have shown that the major LSSR units attain 200m thickness or more in parts of this subregion. The Kimmeridge and Oxford Clay Formations are formed mainly of mudstones with some thin siltstones known from outcrops and boreholes within the East Anglia region. The Lias and Mercia Mudstone Groups comprise mudstones interlayered with other sedimentary rocks. The Lias Group is up to 230m thick under this subregion and, although mudstones dominate, they are interbedded with thin limestones and sandstones over much of the sequence. The Mercia Mudstone Group is up to 500m thick under this subregion and is composed largely of mudstone with siltstone and sandstone layers.

Where individual mudstone beds are sufficiently thick they may have potential as LSSR host rocks whilst thinner units may serve to separate deep groundwater from the 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.

Geophysical surveys (regional gravity data) suggest that the basement rocks that occur in this subregion within the depth range of interest include granite intrusions, with the potential to be HSR host rocks, although granites have not been encountered in boreholes. Information on the nature and properties of basement rocks in the depth range of interest would therefore be required to evaluate their potential as Higher Strength Rock (HSR) hosts.

A summary of the geological attributes of the East Anglia 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 in this subregion have not been significantly affected by folding and no major faulting is identified [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. Several principal aquifers are present in this subregion, including the Chalk Group, the Sandringham Sand Formation and the Great and Inferior Oolite Groups, from which fresh groundwater is abstracted where they occur at shallow depth (less than 200m). Several layers of LSSR are likely to provide hydraulic separation between the deep and shallow groundwater even where these layers are not thick enough to host a GDF. The permeability of the Chalk Group tends to decrease with depth and the groundwater becomes increasingly saline, consequently water supply boreholes in this subregion mainly utilise the top 60m. Water with salinity similar to sea water was found at depths below 400m in the Chalk Group in north-west Norfolk. This water is interpreted as Cretaceous seawater and its presence indicates that little or no flushing of the Chalk Group has occurred for tens of millions of years. Groundwater from depths greater than 400m is unlikely to be suitable as drinking water anywhere in the UK [2].

Despite this likely hydraulic separation, there are 3 very small areas (approximately 1km2 each) where the presence of several deep exploration boreholes may influence connectivity between shallow and deep groundwater and would need to be considered during the siting process (see Figure 2). There are no thermal springs in this subregion to suggest rapid flow of deep groundwater to the surface.

Resources

There are no known resources in this subregion and therefore the likelihood of future human intrusion is 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 1a The areas of the East Anglia subregion 1 where any of the 3 Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

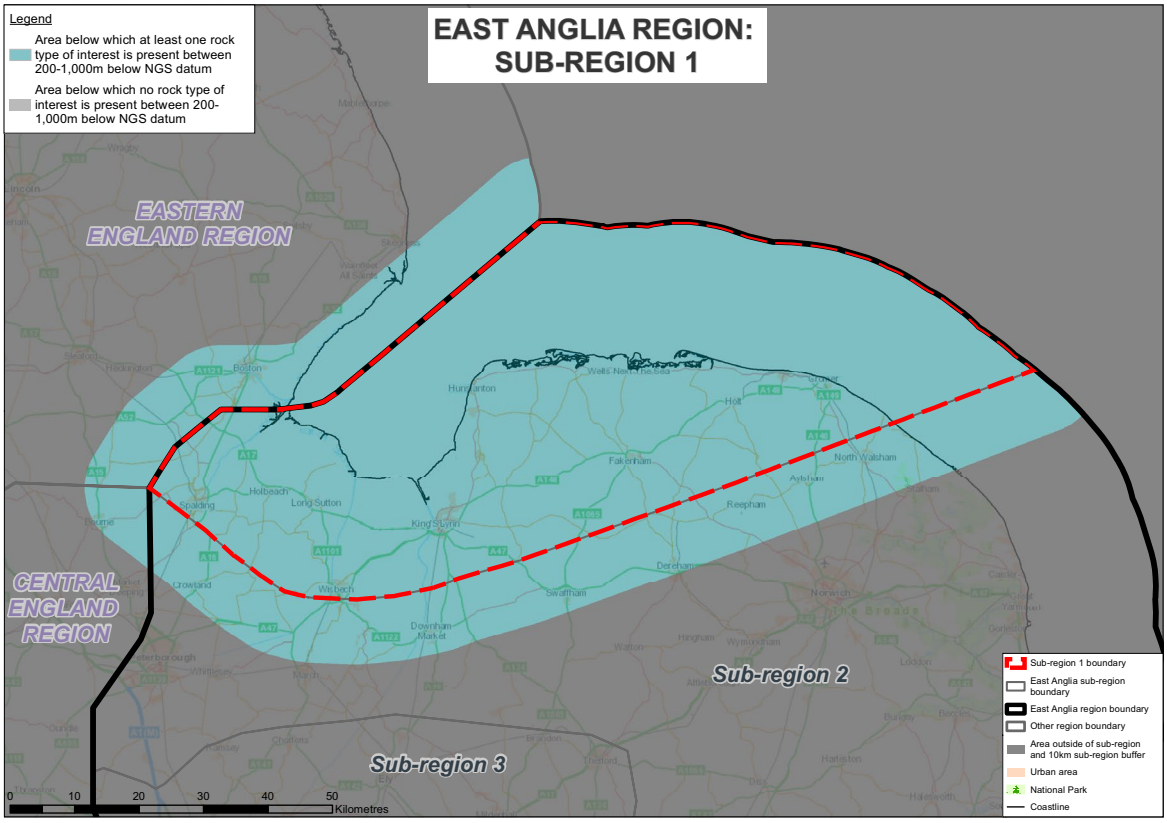


Figure 1b The areas of the East Anglia subregion 1 where Lower Strength Sedimentary Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

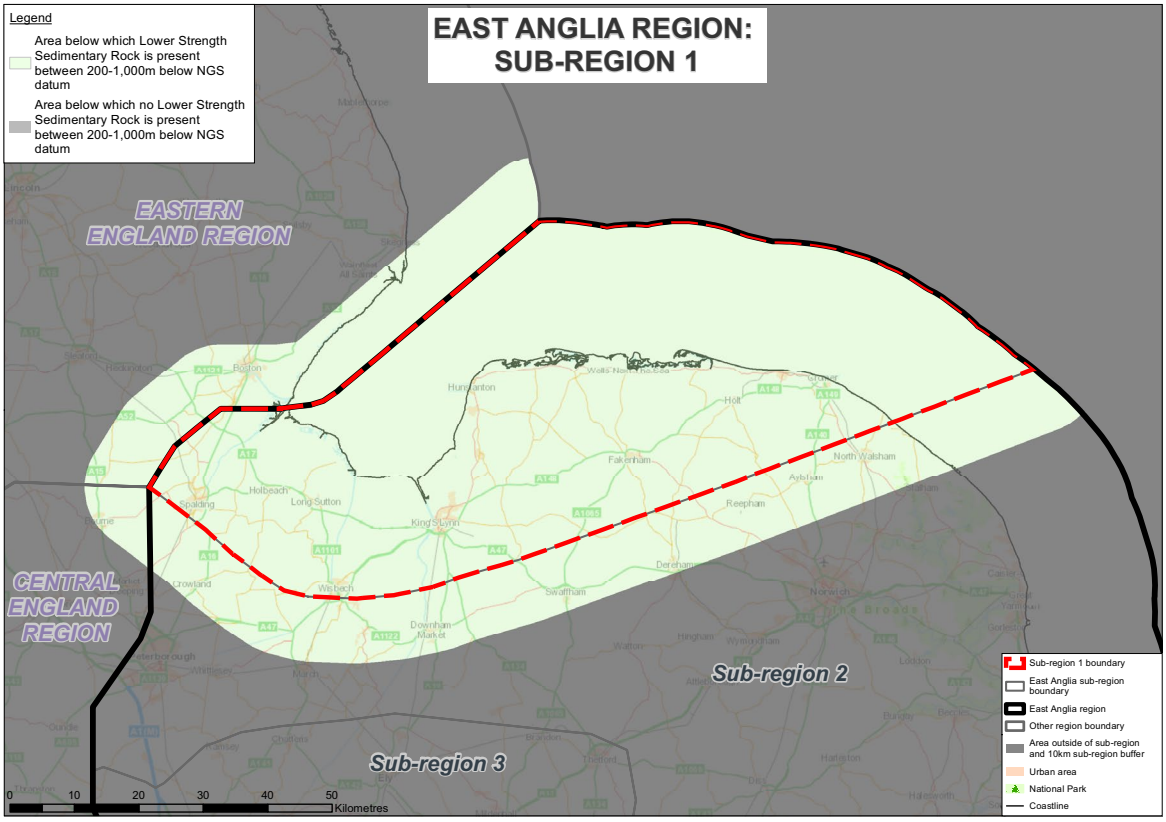


Figure 1c The areas of the East Anglia subregion 1 where Higher Strength Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

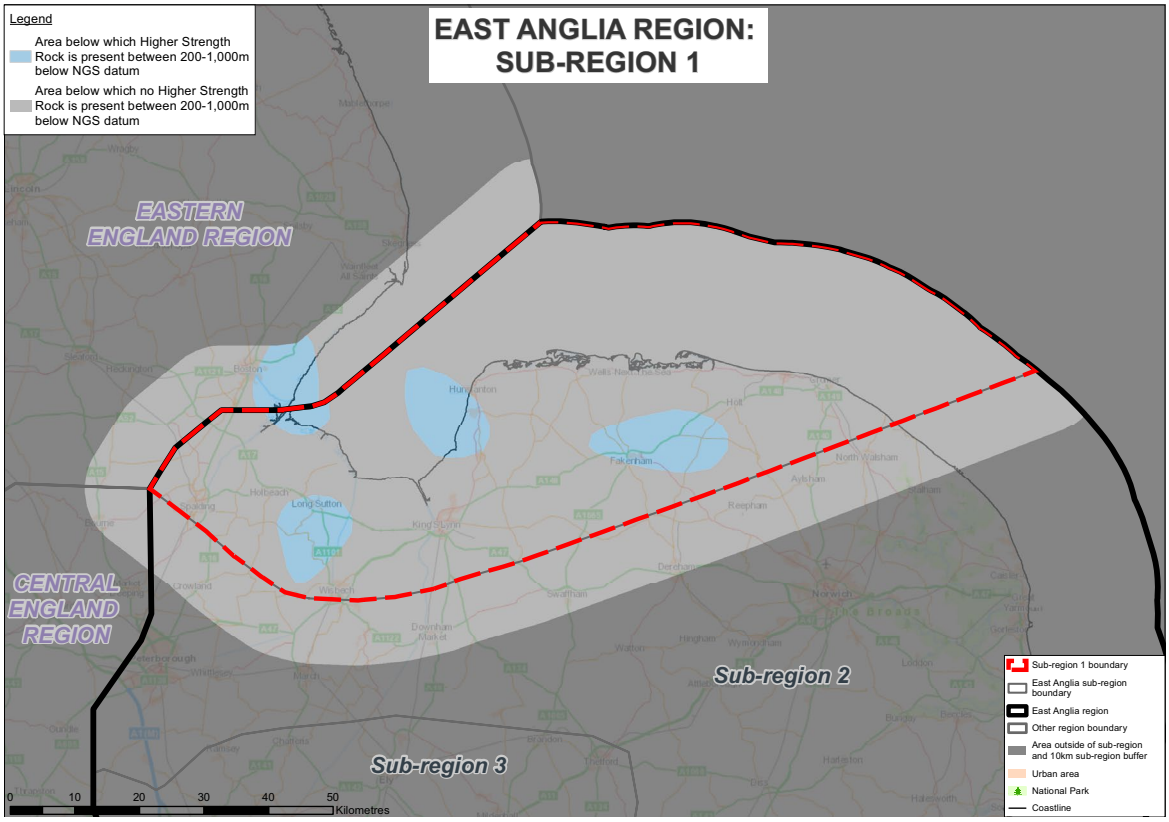
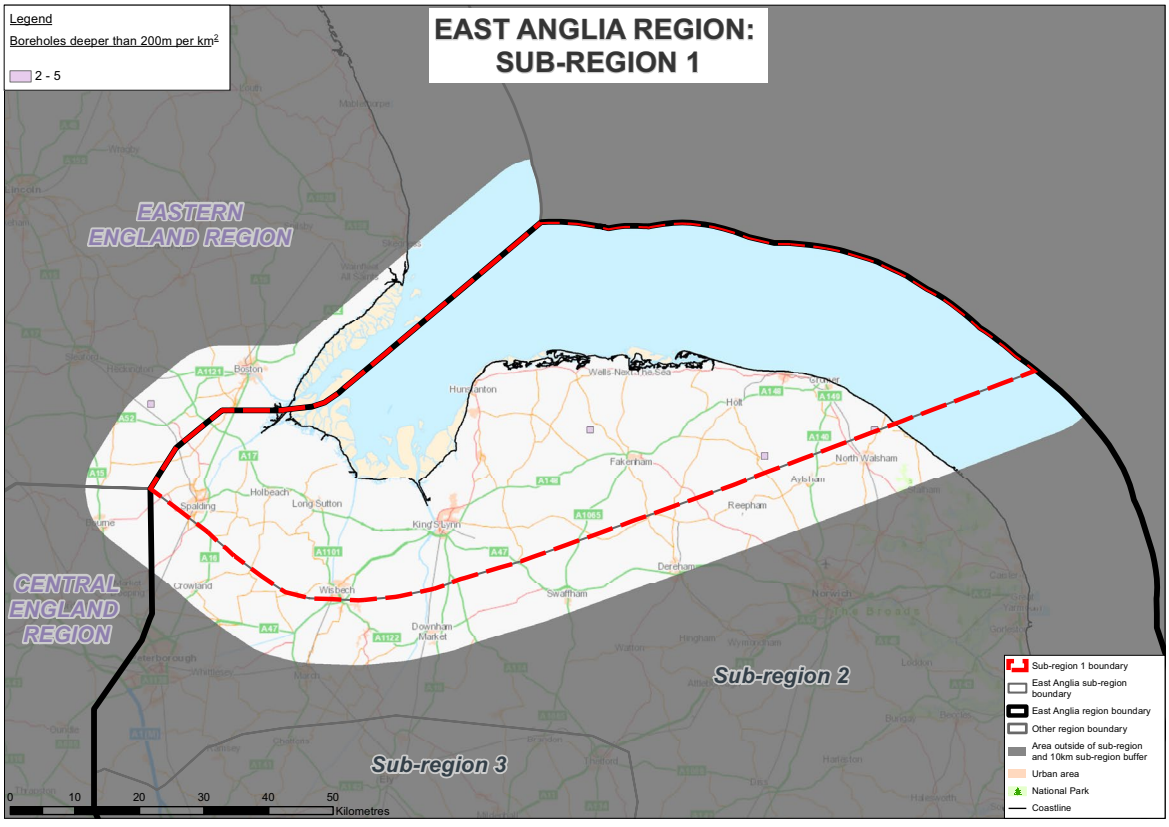


Figure 2 Areas in the East Anglia subregion 1 with concentrations of deep exploration boreholes.



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.

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

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.

Regional gravity data
Geophysical survey that can be used to collect data about the underground geology of an area using sensitive equipment to measure the differences in density of different rock types. Usually these surveys are carried out by aircraft and cover a large area.

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.

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