Notes from Geology Information Seminar held on Monday 15th November 2010

Document No:	123
Status:	Adopted
Author:	Jenny Willis, 3KQ
Title:	Notes from Geology Information Seminar, 15th November 2010
Notes:	None

Background and overview

This information seminar was organized by the West Cumbria Managing Radioactive Waste Safely (MRWS) Partnership, to allow members and their colleagues learn more about the geological screening that has been carried out and how this relates to, but is different from, work done in the past. The seminar was not part of the main deliberation of the Partnership that will occur after Public and Stakeholder Engagement round 2 is complete (Nov 2010 – February 2011).

A full list of attendees can be seen below (Appendix 2).

The following handouts were provided on the day:

- Copies of the letters from peer reviewers of the British Geological Survey (BGS) report – see MRWS website:
  1. http://www.westcumbriamrws.org.uk/documents/111-Reviewer_Statement_-_Agust_(Final_draft).pdf .
  2. http://www.westcumbriamrws.org.uk/documents/113-Reviewer_Statement_-_FWS_(final).pdf .
- Nuclear Decommissioning Authority (NDA) *DRAFT* Briefing note (see Appendix 1). This briefing note is under development and what was shown to the meeting and is included in this report was an initial draft for comment.

Contents:

1. DECC presentation (PowerPoint slides) – page 2.
2. BGS presentation (PowerPoint slides) – page 5.
3. Note on discussions at the meeting – page 9.
4. NDA *DRAFT* briefing note (Appendix 1) – page 12.
5. List of attendees (Appendix 2) – page 16.

DECC presentation:

DEPARTMENT OF ENERGY & CLIMATE CHANGE

MANAGING RADIOACTIVE WASTE SAFELY

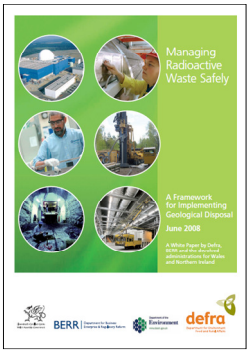
Initial Geological Unsuitability Screening

Andrew Craze

15th of November 2010

Purpose of the report

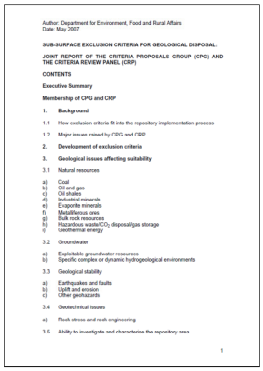
DEPARTMENT OF ENERGY & CLIMATE CHANGE



- Broad brush regional assessment.
- Exclude areas based on criteria in White Paper.
- Geology based only.
- Desk-based study using existing knowledge only.
- Does **not** mean that areas which are not excluded are suitable.
- Applied by British Geological Survey (BGS).

The Criteria

- Criteria Proposal Group and Criteria Review Group.
- Criteria which could be applied anywhere
- Criteria applied with existing information.
- Only consider geology e.g. natural resources and groundwater.
- Consultation in 2007.



Author: Department for Environment, Food and Rural Affairs
Date: May 2007

SUB-SURFACE EXCLUSION CRITERIA FOR GEOLOGICAL DISPOSAL:

JOINT REPORT OF THE CRITERIA PROPOSALS GROUP (CPG) AND THE CRITERIA REVIEW PANEL (CRP)

CONTENTS

Executive Summary

Membership of CPG and CRP

1. Background

1.1 How exclusion criteria fit into the repository implementation process

1.2 Major issues raised by CPG and CRP

2. Development of exclusion criteria

3. Geological issues affecting suitability

3.1 Natural resources

a) Coal
b) Oil and gas
c) Oil shales
d) Industrial minerals
e) Evaporite minerals
f) Metalliferous ores
g) Bulk rock resources
h) Hazardous waste/CO_2 disposal/gas storage
i) Geothermal energy

3.2 Groundwater

a) Exploitable groundwater resources
b) Specific complex or dynamic hydrogeological environments

3.3 Geological stability

a) Earthquakes and faults
b) Uplift and erosion
c) Other geohazards

3.4 Geotechnical issues

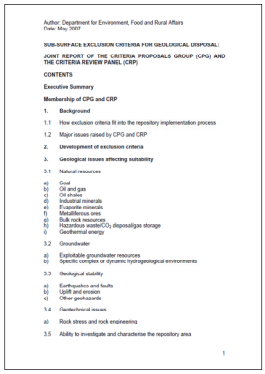
a) Rock stress and rock engineering

3.5 Ability to investigate and characterise the repository area

1

The Criteria

- Criteria Proposal Group and Criteria Review Group.
- Criteria which could be applied anywhere
- Criteria applied with existing information.
- Only consider geology e.g. natural resources and groundwater.
- Consultation in 2007.



Author: Department for Environment, Food and Rural Affairs
Date: May 2007

SUB-SURFACE EXCLUSION CRITERIA FOR GEOLOGICAL DISPOSAL:

JOINT REPORT OF THE CRITERIA PROPOSALS GROUP (CPG) AND THE CRITERIA REVIEW PANEL (CRP)

CONTENTS

Executive Summary

Membership of CPG and CRP

1. Background

1.1 How exclusion criteria fit into the repository implementation process

1.2 Major issues raised by CPG and CRP

2. Development of exclusion criteria

3. Geological issues affecting suitability

3.1 Natural resources

a) Coal
b) Oil and gas
c) Oil shales
d) Industrial minerals
e) Evaporite minerals
f) Metalliferous ores
g) Bulk rock resources
h) Hazardous waste/CO_2 disposal/gas storage
i) Geothermal energy

3.2 Groundwater

a) Exploitable groundwater resources
b) Specific complex or dynamic hydrogeological environments

3.3 Geological stability

a) Earthquakes and faults
b) Uplift and erosion
c) Other geohazards

3.4 Geotechnical issues

a) Rock stress and rock engineering

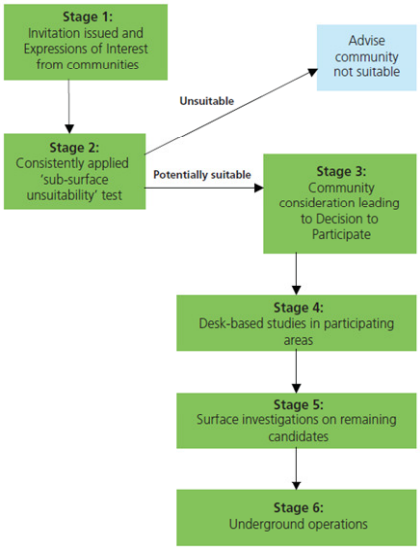
3.5 Ability to investigate and characterise the repository area

1

Reiteration of Purpose

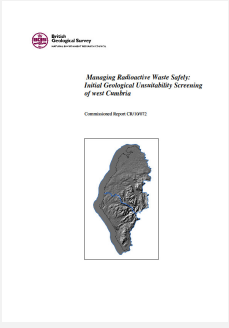
DEPARTMENT OF ENERGY & CLIMATE CHANGE

- BGS report identifies areas that are unsuitable against the high-level criteria.
- It does not show areas that are definitely suitable.
- It does not determine where a facility might eventually be located.
- Detailed assessment using much more extensive criteria if a community chooses to progress further.



What the Report Means

DEPARTMENT OF ENERGY & CLIMATE CHANGE



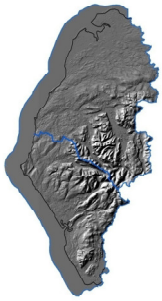
Does not present any reason why west Cumbria cannot continue to consider whether or not to participate in the site selection process for a geological disposal facility.

BGS Presentation:

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Applied geoscience for our changing Earth

Managing Radioactive Waste Safely: Initial Geological Unsuitability Screening of West Cumbria



Dr John Powell* and Dr Colin Waters

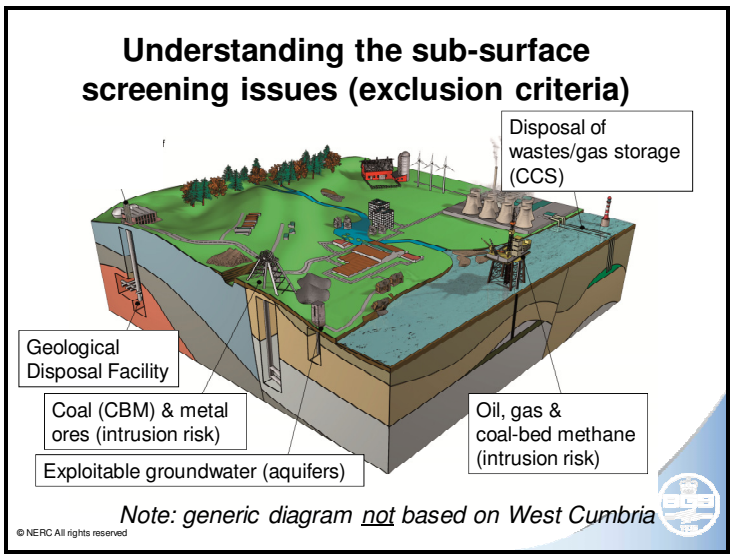
Dr Dave Millward and Dr Nick Robins

*Chief Geologist, England

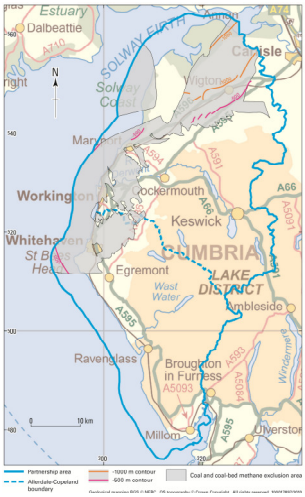
Screening Process

Data sources include:

- Geological map data, cross-sections, interpreted seismic sections & 3 dimensional geological models
- Hydrogeology reports & information including Environment Agency data
- Coal and metalliferous mining information
- Oil and gas exploration data
- BGS publications (regional 'memoirs'; reports etc.)
- Published scientific literature, including summary NIREX reports



MRWS White Paper, 2008	**To be applied as exclusion criteria?**	**Reasons/explanations and qualifying comments**
Natural resources		
Coal (and CBM)	Yes	**Intrusion risk to depth, only when resource at >100m depth**
Oil and gas	Yes	Intrusion risk to depth (for known oil and gas fields)
Oil shales	Yes	Intrusion risk to depth
Metal ores	Some ores	**Intrusion risk only where mined at depth, i.e. >100m depth**
Disposal of wastes/gas storage	Yes	Only where already committed or approved at >100m depth
Groundwater		
Aquifers	Yes	**Where all or part of the geological disposal facility host rock is located within the aquifer**
Shallow permeable formations	Yes	**Where all or part of the geological disposal facility host rock would be provided by permeable formations that might reasonably be exploited in the future**
Specific complex hydro-geological environments	Yes	Deep karstic formations and known source rocks for thermal springs



Coal & Coal-Bed Methane Exclusion Area

Intrusion risk for exposed and concealed coalfield >100m depth

Oil and Gas Exploration

Intrusion risk to depth for <u>known</u> oil and gas fields

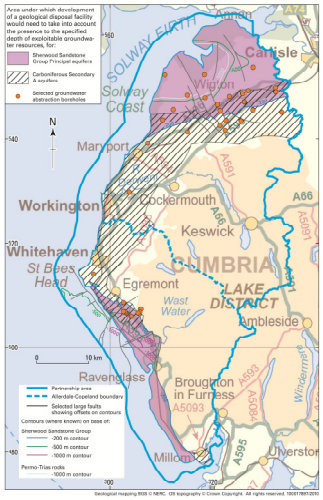
Current oil and gas exploration licence areas (DECC)

- Deep hydrocarbons exploration boreholes

Metalliferous Mining Exclusion Area

Intrusion risk for hematite iron ore >100 m depth

Hematite iron ore exclusion areas



Exploitable Groundwater Aquifers

(Sherwood Sandstone Group Principal aquifer and Carboniferous Secondary aquifers)

Sherwood Sandstone Principal aquifer, onshore; excluded rock volume from 200 m to 500 m depth

Carboniferous Secondary 'A' aquifers; onshore; excluded rock volume from 200 m to 500 m depth

Selected groundwater abstraction boreholes (from EA data)

SUMMARY of EXCLUDED AREAS*

*Where whole rock volume is excluded between 200 and 1000m depth

Risk of 'intrusion' for:

Coal & Coal Bed Methane
and
Hematite iron ore

Note on discussions at the meeting:

Technical points are largely covered by NDA's briefing note but here is a synopsis of other issues discussed at the seminar. Dr Jeremy Dearlove (FWS Consultants), a peer reviewer contracted to scrutinise the BGS screening report offered to answer any further queries on geology as they emerge. Please contact the Partnership by email (contact@westcumbrianmrws.co.uk), or telephone (0800 0488912) if you would like to get in touch with him.

Process

There were several issues raised relating to the process:

- There was recognition that some people were still of the view that geology should have been considered first, rather than using the concept of voluntarism to identify willing communities before considering the geology of an area. It was reiterated that this debate took place in the development of the White Paper and that different technical solutions could be applied according to the geology in any area that went ahead with a decision to participate in the siting process.
- It was stated that potential suitability couldn't be robustly examined over such a wide area at this early stage, hence the need for determining the suitability of a site coming later on in the process. This is why the desk based screening undertaken by the BGS so far is aimed at screening out areas which are unsuitable for further consideration. Further down the line **if** an apparently suitable site is found much more information will be required in order to look at the full safety case which would show how the proposed facility would meet the relevant safety and environmental criteria established by the regulators.
- It was made clear that the Partnership has not yet formally reached any conclusions in relation to confidence in BGS survey or that the area left is large enough to continue with the process. This seminar was another opportunity to inform members' deliberations.
- Many issues discussed in the context of this seminar consisted of detail which will be relevant later on if the process continues to a point where a safety case is being made for particular sites.

Criteria

A safe GDF could potentially be constructed in a range of geological settings (e.g. hard rock, clay, salt) and the MRWS process therefore does not seek any specific geology. However, there is a need to apply some consistent high-level tests to quickly rule out areas that are obviously geologically unsuitable as judged against some generic high level criteria that could be easily applied at an early stage anywhere in the country. This was the purpose of the sub surface unsuitability test carried out by BGS. In addition the Environment Agency have published in their Guidance of Requirements for Authorisation the safety and environmental criteria which would apply to a geological disposal facility in any geology.

National Park
It was noted that a large part of the area not screened out by the BGS study included the National Park which can be seen by the shaded area on the BGS map. The degree to which this is relevant has yet to be debated.

Depth
There was a brief discussion regarding the potential depth of the repository. It is expected that the depth would be between 200 -1000m (as advised by CoRWM) but this does not rule out going slightly deeper than this if this was considered to be to be both practical and desirable in the case of specific sites. However there would have to be a clear benefit to going deeper because of increasingly difficult conditions to be overcome in excavating a facility at greater depth.

Data sources
All data sources used in the BGS screening are referenced and are either publicly available or can be made available on request to those who wish to look at them in more detail. There are further data sources that will be considered in later stages if the process continues. A specific example of this was in relation to Harwell reports considering the issues of tectonics and faulting.

Colloids
A concern was expressed about the potential danger of colloids transporting radionuclides. It was explained that colloids are very small particles that remain suspended in a liquid and could provide a mechanism for the movement of radionuclides. This possibility is recognised and information would be obtained during site investigations to allow the effect on the suitability of specific sites to be confirmed. The effect of colloids is believed not to be significant in saline water which is what is generally found at the depth being considered for a repository.

Aquifers
There was a discussion about whether a repository could potentially be positioned below an aquifer. The meeting was advised that, in the NDA's view, there would not be a fundamental problem with accessing an appropriate volume of rock through an aquifer. The Environment Agency would however have to be satisfied about the safety case in such a situation due to its statutory responsibility for groundwater resources.

Retrievability
The issue of retrievability of the waste has been a subject of discussion since CoRWM's 2006 recommendations. Government's view expressed in the 2008 White Paper is that the decision about whether or not to keep a geological disposal facility (or vaults within it) open for an extended period of time can be made at a later date in consultation with the independent regulators and local communities. In the meantime the planning, design and construction can be carried out in such a way that the option of extended retrievability is not excluded.

Scientific advances and impacts on risk

The main areas of discussion related to scientific advances particularly in relation to modelling, and their associated impact for risk assessments:

- The meeting was told that there have been big advancements in the understanding of ground water flow and in 3D seismic surveying and computer modelling (see NDA briefing for this seminar) but there was also a question about whether the same advances have been made in relation to tectonics. It was reported that relevant experience from Sweden and Finland will be useful, particularly when seeking to avoid the possibility of shear failure where a 'guillotine movement' of rocks could potentially cut through a waste container. There have been experiments to reproduce the relevant conditions with control so that it is possible to determine what the engineered solution would have to withstand.
- It was felt that many concerns which were present during the NIREX process in the 1990s about groundwater movements would benefit from the greater scientific understanding developed since that time, particularly the ability to model ground water flows in a way that could pinpoint risk much more accurately than previously.
- The improved modelling systems would enable design teams to run 'worst case scenarios', and to be transparent about methods used and conclusions drawn e.g. when considering ground water movement 3D seismic modelling would be able to show any possible direct routes to the surface.
- There was a question about the fact that although there have been developments in techniques and processes since NIREX which can be used to more accurately assess risk and therefore safety these developments could also highlight factors we need to be *more* concerned about than previously. However the consensus was that NIREX and then NDA had been keeping in touch with global developments and that nothing new had emerged in terms of concerns. The key difference is that although the NIREX assessments did take uncertainties into account the improved understanding given by modern surveying and modelling techniques will reduce uncertainties to enable a more robust safety case to be established.

Appendix 1
NDA *DRAFT* Briefing note:

N.B. This briefing note is under development and is a draft open for comment.

Nuclear Decommissioning Authority

NDA, Radioactive Waste Management Directorate
Building 587
Curie Avenue
Harwell
Nr Didcot OX11 0RH

West Cumbria MRWS Partnership

Dear Partnership Member

Geological Information Seminar, 15 November 2010

NDA Draft Briefing Note

This note has been produced in response to a request to brief the West Cumbria MRWS Partnership's Geological Information Seminar on the 15 November. This briefing note will provide the basis for the discussion on geological developments that have taken place since the mid-1990s in the five broad areas as requested:

a) Improved understanding of the role of geology in containing radionuclides (i.e. radioactive elements)

b) Improved 3-D seismic surveying

c) Advances in 3-D computer modelling

d) Information relevant to the MRWS site selection process in West Cumbria

e) How geological information will be taken into account under the current site selection process.

The note is currently presented as a draft since the NDA wants to learn from the seminar if there is further information that the local community would like to receive. Any such information will be included in an updated, final version of the note.

a) Improved understanding of the role of geology in containing radionuclides

Geological disposal involves the use of what is termed a multiple barrier approach where engineered barriers and the natural barrier provided by the geology work together to contain the radionuclides associated with radioactive wastes. The main objective of this containment is to prevent or minimise the movement of radionuclides through the groundwater system back towards the surface environment. If radionuclides in the groundwater eventually move out of the engineered system, a number of physical and chemical processes could occur in the deep rock-water system to contain them.

In most of the rocks found at depth in West Cumbria radionuclides would tend to move with the flow of groundwater in naturally-occurring fractures and joints in the rocks. Given the very long times taken for water to flow from depth back to the surface many radionuclides would completely decay to stable, that is non-radioactive, nuclides before reaching the surface environment even if they travelled at the same rate as the groundwater. However, this would not be true for very long-lived radionuclides and a number of processes that prevent or retard their movement in relation to groundwater flow are therefore important.

Work in this area over the last 15 years, in Sweden in particular, has given a great deal more confidence that two relevant processes can be characterised and applied in assessing the "transport resistance" of the geology.

- One important process involves the diffusion of radionuclides out of the water in the fracture carrying flow and into stagnant water in closed-ended pores in the rock adjoining the fracture, where the radionuclides essentially become trapped. Work in Sweden and elsewhere now allows scientists to combine experiments on rock samples taken from boreholes with measurements taken on the rock walls of boreholes to determine the extent to which this process will operate.
- A second important process is termed sorption and involves the transfer of radionuclides out of solution in groundwater onto the solid surface of minerals on the rock wall of a fracture or pore. There has been a major international effort over the past 15 years to improve the understanding of sorption such that many of the uncertainties about its effectiveness, that had to be taken into account previously, have been removed.

b) Improved 3-D seismic surveying

3-D seismic surveying can give a detailed picture of the structure of rocks at depth, including the "discontinuities" in the rocks that could control groundwater movement. Since the former Nirex carried out a trial survey in the 1990s, other waste management organisations, notably Nagra in Switzerland, have successfully built on that, and oil-industry experience, to use the technique to characterise the detailed structure of large volumes of rock having the potential to host a disposal facility.

c) Advances in 3-D computer modelling

3-D modelling of groundwater flow through the large volumes of rock relevant to geological disposal has been possible for some time, but until recently was unable to represent the detailed structure of the rock that would control the precise pathway taken by the water. Partly driven by radioactive waste management programmes in other countries such as Sweden, Finland and Canada, computer modelling techniques have now been developed that can calculate the tracks of particles of water flowing from depth to the surface environment through a volume of rock that has been adequately characterised. These computer models have been tested in international co-operative programmes such as the Äspö Hard Rock Laboratory (Sweden) Groundwater Modelling Task Force. Their use in safety assessments in Sweden continues to be scrutinised by their independent regulator and its scientific advisors.

d) Information relevant to the MRWS site selection process in West Cumbria

It is clearly important to take account of what was learned about the geology and hydrogeology of West Cumbria, particularly around the Longlands Farm site, from the investigations carried out by and for the former Nirex. The information that Nirex presented to the Rock Characterisation Facility (RCF) Local Planning Inquiry in 1995 was based on less than 25% (in cost terms) of the geological information that it had acquired by the time investigations were halted. The information available in 1995 did not enable an adequate understanding of the controls on groundwater flow or of some of the field observations, as was acknowledged in Nirex's reports on its modelling work.

When the full suite of information was available later, groundwater flow models were developed by many of the UK's recognised hydrogeology experts and, following independent peer review, were published in December 1997 in "Nirex 97" as a means of documenting the outcome of the work programme. These models took account of all the features and processes that could control the flow of groundwater, including:

- the topography and rainfall of West Cumbria,
- the various types of water found at depth,
- the fracture zones in the deep rocks, and
- the hydrogeological properties of the rocks and their fractures, joints and pores.

The models, which were tested against field observations not used in their development ("independent test data"), showed groundwater flows and flow paths consistent with safe disposal of long-lived radioactive wastes (the UK intermediate-level waste inventory) at the Longlands Farm Site. The British Geological Survey integrated information from the Nirex studies into its Memoir "Geology of the West Cumbria District", also published in 1997.

If potential candidate sites were to be identified through the site selection process and this historical information was relevant to their evaluation, there would clearly have to be a due process of scrutiny as outlined in the next section.

e) How geological information will be taken into account under the current site selection process

The MRWS site selection process recognises international experience that to be successful it should be based on an approach of voluntarism and partnership. Candidate sites that are identified by a local community engaged in the process and agreed by Government will be subject to evaluation for suitability against key criteria including the site's geological and hydrogeological characteristics. At various stages of the site selection process, the independent environmental regulator requires that safety assessments will be presented to show, amongst other things, how the site's geological and hydrogeological characteristics are consistent with meeting safety requirements. Before a GDF can be developed a full safety case must be presented for scrutiny and agreement by the regulators.

We look forward to this seminar and addressing the questions, comments and observations that you will raise.

Yours faithfully

Alun Ellis

Repository Director

Appendix 2

List of attendees

Alan Tyson, ABC
Charles Holmes, ABC
Chris Shaw, CALC
Keith Hitchen, CALC
Guy Richardson, CALC
Ranald Stewart, CALC
Steve Smith, CBC
Yvonne Clarkson, CBC
Norman Clarkson, CCC
Eileen Eastwood, CBC
John Rennilson, CoRWM
Lindsay Gray, Churches Together in Cumbria
Andrew Craze, DECC
Gavin Thomson, Environment Agency
David Brazier, Environment Agency
Dave Polhill, Gosforth Parish Council
Mike McKinley, Gosforth Parish Council
Adrian Dalton, Drigg Parish Council
Alun Ellis, NDA
Alan Hooper, NDA
Marcus Swift, Prospect
Jeremy Dearlove, Independent Peer Reviewer, FWS Consultants
Rhuari Bennett, 3KQ
Jenny Willis, 3KQ