

GEOSCIENCES AND THE LONG-TERM MANAGEMENT OF RADIOACTIVE WASTE

Geological Society Meeting

January 9 2006

5 members of CoRWM attended: GM, FW, PW (part), WD, LW. These notes are based on notes that I took at the time; given more time I would have tried to draw things together better but this is the best I can do. Where there are abstracts I have not attempted to repeat what is written. We were told at the end of the meeting that speakers will be encouraged to make their presentations available for placing on the Geological Society website. My personal view is that it would be very useful for CoRWM members to have copies of these – there was a lot of useful information and references.

My general impression and conclusions – and these are personal conclusions that the other CoRWM attendees may dispute are as follows:

- *Geological disposal is THE option, for some of the waste at least*
- *Boreholes were not ruled out, however, for HLW wastes such as plutonium where irretrievability is at a premium*
- *Subductions zones are not suitable*
- *Stable geology is needed but it could be hard rock or clay (some slight indication that clay performed better)*
- *Choice of rock should determine choice of engineered barrier system (EBS)*
- *Retrievability did not figure largely and some clearly saw it as counter to the main objective of disposal*
- *There will need to be a long lead in time – site characterisation will not be straightforward and may prove controversial.*
- *Volunteerism is the way forward*

1 Introduction: The Links Back to the 1999 Report

Peter Styles

President, Geological Society; Director, British Geological Survey; Professor, University of Keele

No Abstract provided.

Geol Soc 1999 Report concluded that the only option was deep geological disposal at several 100 metres depth. He considered changes in circumstances since then, including climate change. Reference to sea level and coastline changes and gave maps with an extreme scenario of 84 m sea level rise creating the British archipelago.

Points of Possible Interest for CoRWM:

Claimed there were only 2 options for waste, above ground and below ground and that, if above ground, this was of no real interest to geologists. Talking to

people over coffee, this view was not shared; earth scientists will have a lot to contribute to above ground solutions in terms of climate change impacts.

2 A UK Overview: Process and Timetable, the Work of CoRWM

Gordon MacKerron

3 The UK Inventory, the Safety Case and the Waste Management Options for Nirex

Alan Hooper

Nirex

Abstract provided

Points of Possible Interest for CoRWM:

- Magnox power stations are not 'waste friendly' and present a challenge.
- Undue focus in past on mathematical modelling – confusing it with long-term safety case which is about a lot more.
- Focused on phased deep disposal for ILW/LLW and reference geological disposal concept for HLW/SNF based on Swedish KBS3 concept.
- 30% land area has potentially suitable site but BGS are currently reviewing this historical research for Nirex.
- Paul Davies (NDA) urged that care should be taken not to oversell geological disposal and asked whether there were any 'achilles heels' that needed to be raised here, because 'they will be later'.
- One of the issues he raised in this context was gas generation, especially the transport of C-14
- Alan's reply was that '**geological disposal is all very well until you get the maps out**'.

4 Progress in Europe – Sweden

Olle Olsson

SKB, Sweden

Abstract provided

Points of Possible Interest for CoRWM:

- 3 key factors in determining site for deep repository for SNF: rock + general safety; industry + environment; society + public confidence.
- Siting process started in 1993; hoped for 5-10 potential sites and got 8 for feasibility studies; narrowed down to 2 and expect to select in 2008 (**i.e. 15 years**)
- Approx 70% public approval in host communities; dropped to 40% at another site (**inverted nimbyism**)

- Risk target of $<10^{-6}$ pa over assessment period of 1 million years – over one glaciation cycle.
- Glaciation appears to be most significant effect – added pressures; melt.
- Both sites appear suitable; hope to be able to submit application in 2008 following detailed safety analysis. Then ‘complex legal process’ but hope to start construction beginning of next decade and start operations in 2017 (**i.e 19 years after application**)
- Note that Swedish geology is relatively homogeneous; sites are being sought in the Fennoscandian shield with granites and gneisses (crystalline rocks)

5 The Long-term Performance of a Claystone Barrier for a High-level Radioactive Waste Repository in Switzerland: An Evaluation Using Multiple Lines of Evidence

Andreas Gautschi
Nagra, Switzerland

Abstract Provided

Points of Possible Interest for CoRWM:

- Demonstration of disposal feasibility went to government in Dec 2002; national and international review from 2003-5 and **public consultation from Sept – Dec 2005**.
- Expect favourable government decision in 2006
- Note that Switzerland has both crystalline, hard-rock geology and sedimentary clays. The hard geology is essentially in the alpine regions to the south where tectonic movements are continuing (the Alps are getting taller); the sedimentary rocks are in the north and are more stable. This neat differentiation makes it relatively easy to decide which type of rock to go for.

6 Technical and Scientific Advances made by Andra in the Investigation of the Meuse/Haute-Marne Site

Christian Ravenne
ANDRA, France

Abstract provided

Points of Possible Interest for CoRWM:

- 1991 Waste Act specifies areas of research and responsible bodies and **defined date for parliamentary date (2006)**
- Government decision to hold public debate in September 2005
- Debate organised by **National Committee for Public Debate**

- Aim is for Government Bill in first quarter of 2006, Parliamentary debate in second quarter with decision within 2 months (**so could be before CoRWM reports**)
- If approval is given (for clay – work on granite is less well developed), expects at least a further 15 years research
- **'Reversibility' is required by law; it requires flexible management of packages in repository, possibility of step-wise closure towards an increasingly passive configuration.**
- Both crystalline hard rock and clay were considered on geological grounds; reason for prominence of clay is social – difficulty of finding site to investigate for hard rock

Stability in the Context of Waste Management Overview and Evidence

Neil Chapman

ITC Switzerland; Sheffield University

Abstract Provided

Points of Possible Interest for CoRWM:

- Noted that first suggestion of geological disposal was US National Academy of Sciences publication in 1957 'Disposal of Radioactive Wastes on Land'.
- Traditional approach is to look at multiple barriers working in time sequence so that containers provide isolation until they corrode; engineered barriers prevent escape into geosphere, geosphere selected to slow down release into biosphere. Neil questioned this logic. Starting point is that there will be a 'back to nature' decline in radioactivity and can use a uranium ore site as comparator for this. Decay to this level will occur over one to a few hundred thousand years for ILW and a few thousand years for HLW. Therefore **focus should be on ensuring that the geology 'supports' the engineered barrier system (EBS) over this period** rather than worry about what happens after repository radioactivity falls below his natural analogue.
- Yucca Mountain is a very difficult site chosen for political not geological reasons. Could get away with 100,000 years but change to 1 million will present problems because of vulcanicity and seismic changes in this period
- In response to questions as to situation in Britain where no homogeneous blocks, said **can never find ideal site but should be able to match engineering to geological environment** – start with geology.

Repository Engineering – Principles and Recent Advances

John Hudson

Imperial College, Rock Engineering Consultants

Abstract Provided

Points of Possible Interest for CoRWM:

- We are looking to do something that does nothing, i.e going against nature (cf normal tunnel construction etc).

Accuracy of Prediction of Subsurface Fluid Flow: Experience from Oilfield Reservoir Modelling

Mike Christie

Heriot Watt University

No Abstract Provided

The author's experience is in the oil industry; he has no direct interest or expertise in radwaste. He made some interesting observations on the use of models for predictions.

Points of Possible Interest for CoRWM:

- Confidence in prediction requires 3 things: good data; a sound physical theory; a good numerical model.
- Need for adaptive sampling and reliance on Bayesian rules for probabilities
- Seemed to be suggesting that the scope for uncertainties in inferences is very difficult
- Maximum likelihood can be a poor predictor in practice
- Need multiple matched models with probabilistic forecasts

Stability and the Geological Settings in the UK

David Holmes

British Geological Survey

Abstract Provided

Points of Possible Interest for CoRWM:

- 1985 criteria for siting have not changed much – major exception is that may now be seeking to keep the repository open for longer
- Looked at what has changed since BGS previous review (?1985): better understanding of requirements for geological barrier; climate change; improved data handling and modelling; previous list based on ILW; did not consider HLW
- Possible new criteria: more emphasis on geochemistry (geochemical stability, microbial activity at depth); climate change; palaeohydrology
- Stability is most important factor and agreed that it needed to be demonstrated over 10-100 Ky not 100K-1 million as previously
- Need to understand natural conditions now and the impact of disturbance upon them

- Discussed landscape stability – i.e. near surface: climate change, sea level rise, flooding, coastal/riverine erosion, tsunamis, permafrost, glacial activity
- Discussed geological stability – weathering patterns, compaction, vulcanism (not so very far away from nearest volcano)
- Type of construction may need rethink if keeping repository open longer
- Knowledge base – learning and forgetting from the past
- Also covered societal stability and competition for geological resources.
- In questioning, subduction zones were raised as something to look at but audience response was highly dismissive with repeated references to the recent tsunami.

Technical Summary, the UK Situation

David Savage

Quintessa

Abstract Provided

A good overview paper, covering the main issues in a clear, easy to understand presentation.

Points of Possible Interest for CoRWM:

- **Retrievability is “quite controversial”**: places strong constraints on design and site selection
- Move towards clay – internationally developing preference: diffusion-controlled transport; self-healing fractures; preservation of past evolution; explorability.
- But, 20 y knowledge gap since Nirex’s investigation of shallow sites (audience queried the seriousness of this citing UK involvement in overseas work)
- EBS would need to be tailored specifically for clay
- Most clays in SE, therefore probably non-starter
- In summary: huge advances in some technical areas; further effort needed re HLW, site characterisation; further debate needed re retrievability, volunteerism, deep boreholes
- **Key hindrance is political and public will; technical problems fairly minimal**

Taking Forward the Science – An Outsider’s View

Joe Cann

University of Leeds

Abstract Provided

Points of Possible Interest for CoRWM:

- **Public distrust models – often wrong and can only deal with the foreseen not the unforeseen**
- Advantage of geologists is that they think in the right time scales
- Advocated the use of natural analogues
- Said it was “given” that radioactive waste must be disposed of; we made it so we must deal with it; deep geological disposal is the only option – retrievability is a side issue
- Question, therefore, was how to energise and inform a rational public debate ending in an acceptable political solution.
- In questions it was suggested that “all models are wrong but some are useful”; Cann disagreed: “all models can be right but bear no relation to real world”.
- Question: **is there a large population of academic geologists that believe the geological ‘in crowd’ are biased in saying that geology plus suitable EBS will work? Answer: No; very close to solution; gap lies in persuading the public**
- Believed there are a **number of potential sites in the UK and a number of potential methodologies**
- Was not concerned at ‘dilute and disperse’ as alternative to ‘concentrate and contain’ in the context of release of radioactivity into the geosphere in the distant future because the mechanisms re movements of more mobile elements from repository to groundwater at about 100°C are well understood

Lynda Warren
January 13 2006