NATURAL ANALOGUE

Working Group

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### NA in stakeholder communications The view of the stakeholders

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Natural analogue information has been used extensively in the past to provide material for public communications applications:

- provides a valuable method for developing arguments for more technical stakeholders
- •...but, impact on the general public has been significantly less than would be desired
- Confidence-building has received greater emphasis recently, particularly associated with perceived need for public acceptance; so far little emphasised in NA projects.

Special concern for NUMO – how to gain the interest and support of the majority of the public, who may be classified as generally uninformed but anti-nuclear on the basis of gut feeling.



### **2. Who are stakeholders**



# 3. What message to target stakeholders?

- ✓ In principle, almost all people agree that "We have to specify a solution of how to manage radioactive waste".
- ✓ According to a NAS report, "geological disposal concept" is not accepted in general public in Japan. This message causes confusion and need for "confidence building and acceptance"



#### **Can NA provide any useful messages for target stakeholders?**

## 4. Gap between stakeholders

#### Gap between sociologists and geological disposal experts

<ol> <li>Deep underground is more dangerous</li></ol>	<ol> <li>Deep underground provide much more</li></ol>		
than near surface <li>Risk of accidents (flood, roof-fall),</li>	suitable conditions than near surface to		
difficulty of rescue / recoveryoften	assure long-term safety. <li>Even in case of perturbations, stable</li>		
reports of death of mine workers	geological barrier keeps waste safe.		
<ul> <li>2. Dangerous waste should be under</li></ul>	<ul> <li>2 Passive barriers are essential to provide</li></ul>		
active human control <li>Wisdom of humans is accepted: fear of</li>	long-term safety. In principle, do not rely		
something happening but not	on any institutional control. <li>Highest uncertainties is future activity of</li>		
recognized if monitoring not included.	human beings.		
3. We recognize that it is very difficult to	3. Step-wise approach and public		
change any decision if there is no law	involvement are key issues in waste		
defining the decision making process	management: Retrievability and		
(especially, public involvement)	Reversibility are assured.		
4. We are much concerning our children health not for far future health effect.	4. Safety case can provide confidence of long-term safety.		

#### **Can** we improve communication using NAs?

5. NA messages to stakeholders; some examples "Uses and abuses of analogues"

- Uses
  - Improving system understanding
  - Model / code / database testing (validation)
  - Safety Case support
  - Training / education
  - Public communication and confidence building
- Abuses
  - The interpretation of natural analogues requires good understanding of both the process or feature observed and the extent of its applicability to a repository system. Lack of such understanding in many cases means that NA literature should be used with great caution. Typical problems involve:
    - Over-interpretation
    - Bad science

### **Archaeological analogues - materials**

Artefacts which have been recovered from relevant settings can provide evidence for the longevity of materials used in repositories

 in some cases measured corrosion rates can be compared with PA model predictions

 limitation - analogy constrained by extent of similarity of material and burial conditions





## Archaeological analogues – material combinations

- A combination of barriers preserved a 2000 year old body without significant decay
- The tomb belonged to Xin Zhui, who died between 178 and 145 BC
- This and other tombs in the area contained well preserved silk maps and books
- Indicates the barrier role of clay / preservation in low humidity, chemically reducing conditions
- Limitation very unusual case and difficult to extrapolate to repository systems







# Archaeological analogues – other applications

- Stability of caverns
  - Natural and human excavated containing artefacts
- Stability of institutional control systems
  - Particularly for specific national

concepts







Cave art at Chauvet, France about 32 ka old



Ajanta temples, India Up to 4 ka old

## **Archaeology Messages**

Analogue / message	Implementer	/ Regulator	Academi	ics / students	Polit publ	icians / general ic
a.EBS materials may corrode only very slowly	Y		Y		Y	
b.Support for material models	Y - with caveats		Y - with caveats		N too complex	
c.Robustness of multibarrier systems	Y - with caveats		Y - with caveats		Y	
d.Longevity of caverns / infrastructure	Y - with caveats		Y - with caveats		Y	
e.Analogue often abused	Y		Y		N conf	using
Mes	ssage OK	Message modified		Message not	useful	

## **Cigar Lake**

- Very long term (about 1300 Ma) stability of an extremely rich ore body (containing high concentrations of U and a range of other relevant elements including Ni, Co, Mo and Pb)
- Highly effective containment of radionuclides under present conditions with no significant surface radiological signature of the ore, despite the relatively high permeability of the host sandstone formation
- No evidence of criticality, but extensive radiolysis of water would be expected within this rich ore body
- The protective role of the surrounding clay-rich layer appears to function despite the presence of microbes, dissolved organics and colloids in pore waters





Athabasca Basin courtesy of JNR Resources Inc.

#### **Cigar Lake - Conclusions**

- Geological disposal is fundamentally feasible in a suitably stable setting
- Clay-rich materials may contribute to preservation of U ore even in a rather permeable host rock
- Concentrations of specific elements in porewater generally compatible with predicted solubilities
- Fault movement will not necessarily disrupt an isolation system (self healing)
- Presence of colloids does not necessarily disrupt an isolation system
- No evidence of oxidising conditions due to radiolysis but microbial activity may be a contributing factor



#### **Cigar Lake - limitations**

The analogue does **NOT** 

- Give any indication of feasibility of disposal at a different location
- Validate the longevity or performance of bentonite backfills or buffers
- Allow radiolysis models to be verified
- Validate chemical thermodynamic models or databases (variable agreement can as easily be interpreted as "invalidation")
- Provide any relevant information on the behaviour of specific RN based on measurements of ultra-trace concentrations



Like Oklo, the Cigar Lake analogy to specific repositories is often exaggerated

## **Cigar Lake Messages**

Analogue / message	Implementer / Regulator	Academics / students	Politicians / general public			
a.Geological disposal of HLW is feasible	Y - at this site	Y - at this site	Y			
b. Natural actinides / fission products found	N - no relevance	Y - academic interest	Y - focus on Pu			
c.Rich ore isolated for 1.3 Ga	Y - at this site	Y - at this site	Y			
d.No effect of colloids or organics	Y - at this site	Y - at this site	N too complex			
e.No negative effect of microbes	Y - maybe positive?	Y - maybe positive?	N too complex			
f.Confirms solubility models	Y - at this site	Y - with caveats	N too complex			
g.Faulting may not cause disruption	Y - at this site	Y - with caveats	Y			
h.Clay may be powerful barrier	Y	Y - with caveats	N too complex			
Analogue often abused Y		Y	N confusing			
Message OK Message modified Message not useful						

### 6. How to achieve Communication

## An illustrative example – the Manga Safety Case

### Written by Ian McKinley in 2009

...establishing dialogue by not only listening to words, but also understanding the images that words are associated with in different audiences



#### How about hosting a nice radwaste repository?





When a repository is constructed, it will have less impact on the environment than most normal industrial facilities



You have got to be kidding! That stuff must be really dangerous!



You have got to be kidding! That stuff must be really dangerous!

The image of waste "dumping" is common – and, indeed, is exactly what happened in the nuclear weapons programmes before a strong environmental culture developed No – it's really safe. Waste is emplaced deep underground where it can't cause any harm! No – it's really safe. Waste is emplaced deep underground where it can't cause any harm!

Hundreds of metres deep underground, conditions are very stable and, even if very radioactive ore bodies are present, there may be no indication of them on the surface

#### But won't it all be crushed to bits with all the weight on it?



100 Tons



and hence concern about waste being crushed is reasonable – and a real concern in soft rocks



But it's safely packaged in a thick steel overpack But it's safely packaged in a thick steel overpack

Deep underground metals corrode very slowly; buried iron archaeological artefacts thousands of years old have been found in many places





car owners experience!

Even if the overpack fails, the waste is sealed into an insoluble glass matrix Even if the overpack fails, the waste is sealed into an insoluble glass matrix

Radionuclide are mixed together with molten glass to form a solid block. This is like the way in which elements like uranium were mixed in to make coloured glass.

# But the glass could get broken in earthquakes!





When not communicated clearly, the impression is that liquid waste is contained in a glass bottle – obviously not a very sensible disposal option! Harrine Layer Harrine Layer Harrine Layer Hore Water Bromine Concentration (ppm)

Even if radionuclides dissolve, they will be retarded by sorption on clay buffer and rock Even if radionuclides dissolve, they will be retarded by sorption on clay buffer and rock

The retardation capacity of engineered barriers and surrounding rock will delay releases of many key RN for thousands or millions of years. This can be seen in many natural systems But radiation could still get out and cause mutations and cancer





The significance of retardation is not obvious and the fear of radiation reinforced by generations of comics and movies where it causes production of mutated monsters

#### Another member of the public is convinced!

# Well, it was nice talking to you.

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This guy is completely nuts!

### Nice talking to you too.

# How to use NA information in communications?

- Accept that this is a key goal and plan for it when any analogue project is considered
- Presenters who use NA in communication with stakeholders should have confidence and understanding NA messages. Confidence could create reliability with the public.
- Focus on images that clearly and unambiguously convey messages related to public concerns
- Try to involve the media as much as possible (e.g. invite to NAWG, press releases,...)