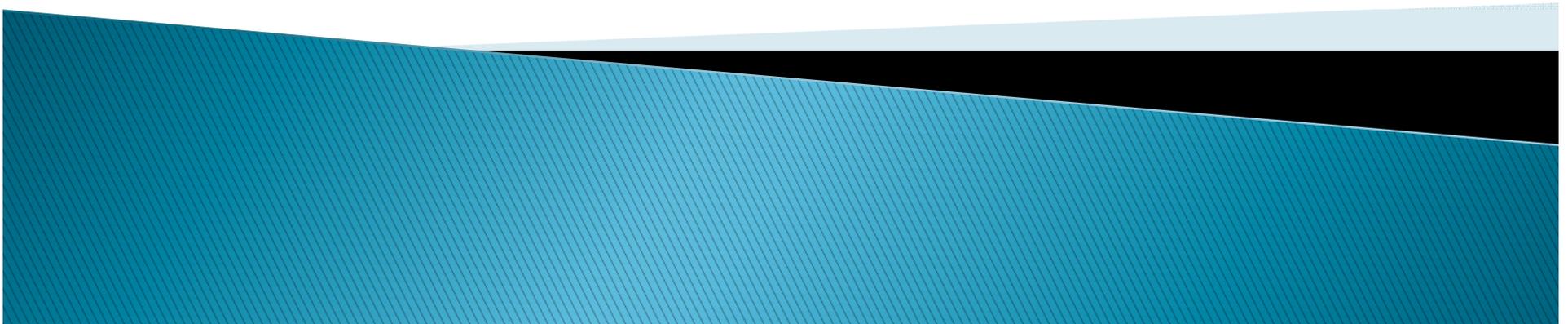


Opportunities and Challenges for Deep Borehole Disposal of Spent Nuclear Fuel in East Asia

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Advantages of Deep Boreholes

- ▶ Many potential sites
 - Can reduce need for large transport distances for waste
- ▶ Potentially lower impact than large repository
 - Lower permeability at depths $> 2\text{km}$ and higher salinity means less potential for water transport
 - Reducing geochemical conditions at these depths usually
- ▶ Insensitive to waste composition
- ▶ Not easily retrievable: “proliferation proof”
- ▶ Cost effectiveness??



Disadvantages of Deep Boreholes

- ▶ Not easily retrievable
- ▶ Not technically mature
 - Diameter of 0.5 m is pushing the limits of borehole drilling at depths >3 km
 - No experience placing materials at this depth



Uncertainties

▶ Cost

- Need life cycle analysis to include
 - Transportation, drilling, casing, repackaging, any additional materials – to package, to borehole

▶ Public acceptability

▶ Technical issues

- Will canister get stuck on the way down?
- Potential to create earthquakes (fracking)
- Performance of casing/interactions in hole
- Use of multi-branched boreholes?
- How well would the seal hold?
- How does high stress environment affect waste over time?



Criteria for Deep Boreholes

- ▶ Tectonic stability
 - No volcanoes, no earthquakes
- ▶ Low permeability crystalline rock
 - Few fractures
- ▶ No natural resources
- ▶ No high heat flow ($<30^{\circ}\text{C}/\text{km}$)
 - Avoids geothermal resource
- ▶ Homogeneous horizontal geology
- ▶ Reducing geochemical environment

- ▶ Note: I do not list “far from populations”!



Comments by Country: China

- ▶ Still early in their decision-making process
 - Though there is an opportunity to set an example for other countries embarking on a nuclear energy program
- ▶ Potentially many suitable locations
- ▶ Could reduce transport needs



Comments by Country: S. Korea

- ▶ Potentially many suitable locations
- ▶ May result in better public acceptance
 - Need to really determine what social and political issues are at play in a repository first



Comments by Country: Japan

- ▶ Boreholes may not be suitable
 - Japan is one of the most seismically active places on Earth
 - Also volcanically active
 - Has high heat flow in many areas
 - Complex geology
 - Overpressured water at depth?



Final Thoughts

- ▶ Both S Korea and Japan: Siting is one of the most significant issues (political, not technical problem)
 - Need to establish which (if either) is more palatable to public: boreholes or repository
- ▶ Need to establish cost of boreholes
- ▶ Need to work on maturing the technology

This may not go as fast as you want/need

