Progress of HLW disposal and planning for the Underground Research Laboratory in China

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Outline

- Policies and regulations
- Progress of site selection in China
- Planning of URL for HLW disposal
- Perspectives
2003: Law on Prevention of Radioactive Pollution:

“high level radioactive waste should be disposed in a centralized geological repository”
Closed spent fuel cycle policy
Design: multi-barriers system

Preliminary conceptual model for China’s HLW repository

- Host rock
- Vitrified waste
- Canister
- Buffer material
Institutional framework

State Council

China Atomic Energy Authority (CAEA)

China National Nuclear Corporation (CNNC) -- possible implementation body

BRIUG  CNPE  CIAE  CIRP

National Nuclear Safety Admin. (NNSA)

Regulatory body

Universities, Chinese Academy of Science

3-stage strategy for HLW disposal

1985 → Site → URL → Repository → 2050
Regulation for fund

- 2010: Waste Fund approved by the State Council:
- Rate: 0.026 Yuan/KWh.
- Used for:
  - Geological disposal
  - Spent fuel transportation & storage
  - reprocessing
Progress of site selection in China
Site selection-History

- 1985 Regional screening
- 1990
- 2000
- 2010
Site selection - History

NW China: Beishan

Xinjiang

Inner Mongolia

SW China

E China

S China
Regional screening
Sub-area selection within Beishan area
Site characterization within Beishan area
New site selection strategy
• Identify 12 potential sites in China;

• After comparison, select 3 sites equally good for the government to make the final decision

• host rock: granite & clay
Beishan area
21 bore holes drilled in Beishan site since 2000

- Jiujing
- Xinchang-Xiangyangshan
- Yemaquan

- BS03
- BS01
- BS02
- BS05 (BS15-16)
- BS06 (BS17-19)
- 5 shallow boreholes
- 3 shallow boreholes
Drilling camp after snow, March 2011
Core samples from BS16
Fracture distribution study

Acoustic borehole televiewer

Fractures Distribution with depth
3D Discrete Fracture Network (3D DFN)

Trace display

Disposal Tunnels and Holes

Borehole modeling

Stress distribution in Beishan area

- The maximum stress is within 25MPa;
- Relatively low stress level;
- Ideal for construction.

Zhao et al., Engineering Geology, 2013.
Hydraulic conductivity measurement

Double packer test system
Mechanical studies

Uniaxial/triaxial compressive test

Chen et al., Int J Rock Mech & Min Sci, 2014;
**Time-dependent behavior of Beishan granite**

- **Axial strain vs. Creep time (s)**
- **Axial stress (MPa) vs. Total experiment time(s)**

Graphs showing:
- Stages of loading: constant lateral deformation rate, constant stress, failure
- Strain and stress curves
- Creep time: primary, secondary, tertiary

**References:**
Beishan area: Preliminary conclusion

- Located in Northwestern China’s Gobi desert area
- Low population density
- Low precipitation: 60--80 mm/a
- High evaporation: 2900-3200 mm/a
- No economical prospect
- No important mineral resources
- Convenient transportation
- Stable crust
- Favorable hydrogeological conditions
- Favorable host rock: granite and diorite

The most potential area for China’s HLW repository
Planning of URL in China
26 URLs built in the world for High-level Radioactive Waste Disposal
Divided into two classes:

- **Generic URLs**: ASPO, Grismel, Mont Terri, Tournemire…
- **Site-specific URLs**: Meuse/Haute-Marne, ESF, ONKALO…

**no clear line between these two classes.**
Located in various types of host rock, including:

- **Granite:** Sweden, Finland, Switzerland, India, Japan, ...
- **Clay rock:** France, Belgium, Switzerland, Japan
- **Salt rock:** Germany
- **Tuff:** USA

*Which is the favorable type for repository project?*

*Not a question with unique answer!*
Here we are

1985  2020  2050
An URL built in Beishan area (Under discussion)
Program I: Basic theoretic and technologic studies
- Design and construction technologies
- Measurement techniques of key parameters
- Security controlling system
- Long-term stability analysis
Underground research facility (-50m)

- Fracture zone
- Ventilation hole
- Experimental gallery
- Small scale fracture zone
- Ramp
R&D Plan before 2020

Program I: Basic theoretic and technologic studies
- Design and construction technologies
- Measurement techniques of key parameters
- Security controlling system
- Long-term stability analysis

Program II: Pre-studies of URL
- Site selection
- R&D planning in URL
- Structural layout and design
- Design of security controlling system
- Data acquisition and management system

Program III: URL construction
- Surface facilities
- Shaft and access galleries
- Experimental galleries
- Other subsidiary systems
Preliminary studies of URL design

Proposed conceptual design- V

Long-distance ramp and vertical shaft
The R&D activities will be carried out stage-by-stage

For the first stage, the attention will be focused on:

- Investigation of deep geological environment
- Characterization of host rock
- Excavation methods
- Testing of long-term performance of buffer material
- Data acquisition and management system

In the future:

- Nuclide migration tests;
- Demonstration of disposal technologies
- ......
Beishan...
Thanks for your attention!