China's nuclear waste: management and disposal

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Talk outline

Section 1: China's Nuclear Power Program, policy and post-Fukushima impacts on spent fuel management

Section 2: China's current and future nuclear waste management

Section 3: Challenges of geological disposal of nuclear waste in China

China's Current Nuclear Program and Policy

- 15 nuclear reactors in operation (12.6 GWe)
  - Qinshan Phase I, II III (7 reactors - indigenous & Canada)
  - Daya Bay (2 reactors - France)
  - Ling Ao Phase 1 (2 reactors - France)
  - Tianwan (2 reactors - Russia)
  - Ling Ao Phase II (2 reactors - localized CPR-1000)
- 27 reactors under construction (29.5 GWe)
- Nuclear power target: 60-70 GWe by 2020

China’s nuclear expansion plan

- The medium and long-term plan (2004)
  - Officially 40 GW by 2020
- The “Rapid growth” reality
  - 80 GW by 2020 (March 2010)
  - Possibly 70 GW (March, 2012)
- Steady development with safety concerns

Current status of post-Fukushima activities

- China officially completed safety inspections for commercial reactors under construction in August 2011
- National Nuclear Safety Administration is still working on the nuclear safety plan and the first draft was rejected by the state council in Feb 2012.
- National Development Reform Commission is working on setting a new goal for China's Medium and Long-term Nuclear Power Development by 2020.

Implications of post-Fukushima activities

- All units under construction were not affected without any construction halt, which signals that those units under construction will very likely move forward without major delay.
- Planned units have to face major design changes to comply with the stricter safety standards.
- The Chinese nuclear industry already appears the urgency to develop domestic next generation technologies after Fukushima

Potential impacts on spent fuel management

- The slower development pace of nuclear power program will decrease spent fuel generation
- Daiichi nuclear disaster experience will result in less on-site spent fuel storage
- Dense-pack method might be removed
- Slowing down the reprocessing project

Section 2 :
China’s current and future nuclear waste management

Low and Intermediate Level Waste

- Two existed LILW facilities
  - Beilong facility located in Guangdong
    - ~205,00 M^3 in total and 80,000 M^3 waste
    - Above ground

Cont'd

- Two existed LILW facilities
  - Yumen facility located in Gansu
    - ~200,000 M^3 in total and 60,000 M^3 waste
    - Under ground (10~20 meter)
- Three future facilities in plan
  - East coast area
  - Northeast area
  - Central area

High Level Nuclear Waste (HLW)

- China has a long-term reprocessing policy for its fuel cycle program and proposed a deep geological disposal method for high level nuclear waste
- Since China's nuclear industry is relatively, China hasn't experienced any pressure from spent fuel and HLW storage
- R&D program is still at the early stage

The three-step plan in progress

- It is expected that China will finish the siting selection and build up an underground laboratory around 2020;
- On-site research activities at the underground laboratory should take place between 2020 and 2040;
- The actual HLW repository will be constructed around 2050.

HLW R&D program

- The China Atomic Energy Authority (CAEA) is in charge of developing plans and projects for HLW disposal
- China National Nuclear Corporation (CNNC) is in charge of implementing R&D activities
- Beijing Research Institute of Uranium Geology (BRIUG) under implements core research projects

Conceptual design

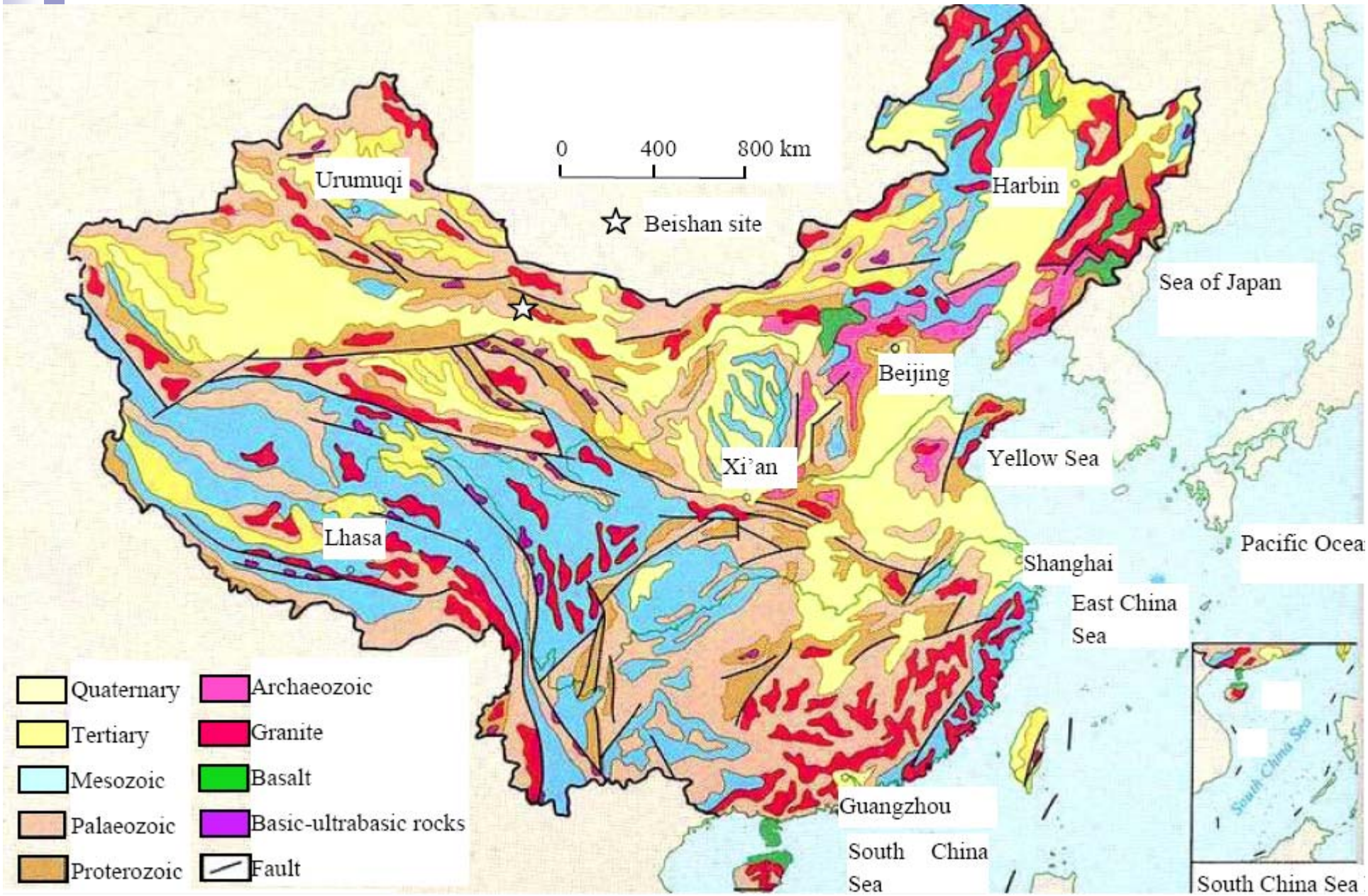
- The preliminary repository concept is a shaft-tunnel system, located in saturated zones in granite.
- The granite is considered as the most suitable host rock and bentonite is proposed as buffer and backfill material.

Current status

- The early projects include studies of regional geological setting, seismic safety, geological and hydrogeological features, rock mass quality investigation, geophysical survey, borehole drilling and borehole tests.
- China has not finalized the permanent location and is still conducting researches in Xinjiang and Inner Mongolia areas.

Current status (Cont'd)

- Five potential sites are chosen, studied and compared and the most promising one is the Beishan area.
- Six deep boreholes and eight shallow boreholes were drilled at three sub-areas in the Beishan area during the period of 2000–2009.
- The results show that the rock mass is of high integrity, low fracture density, low hydraulic conductivity and moderate in-situ stresses, indicating that the Beishan site has a good potential for the construction of future geological repositories.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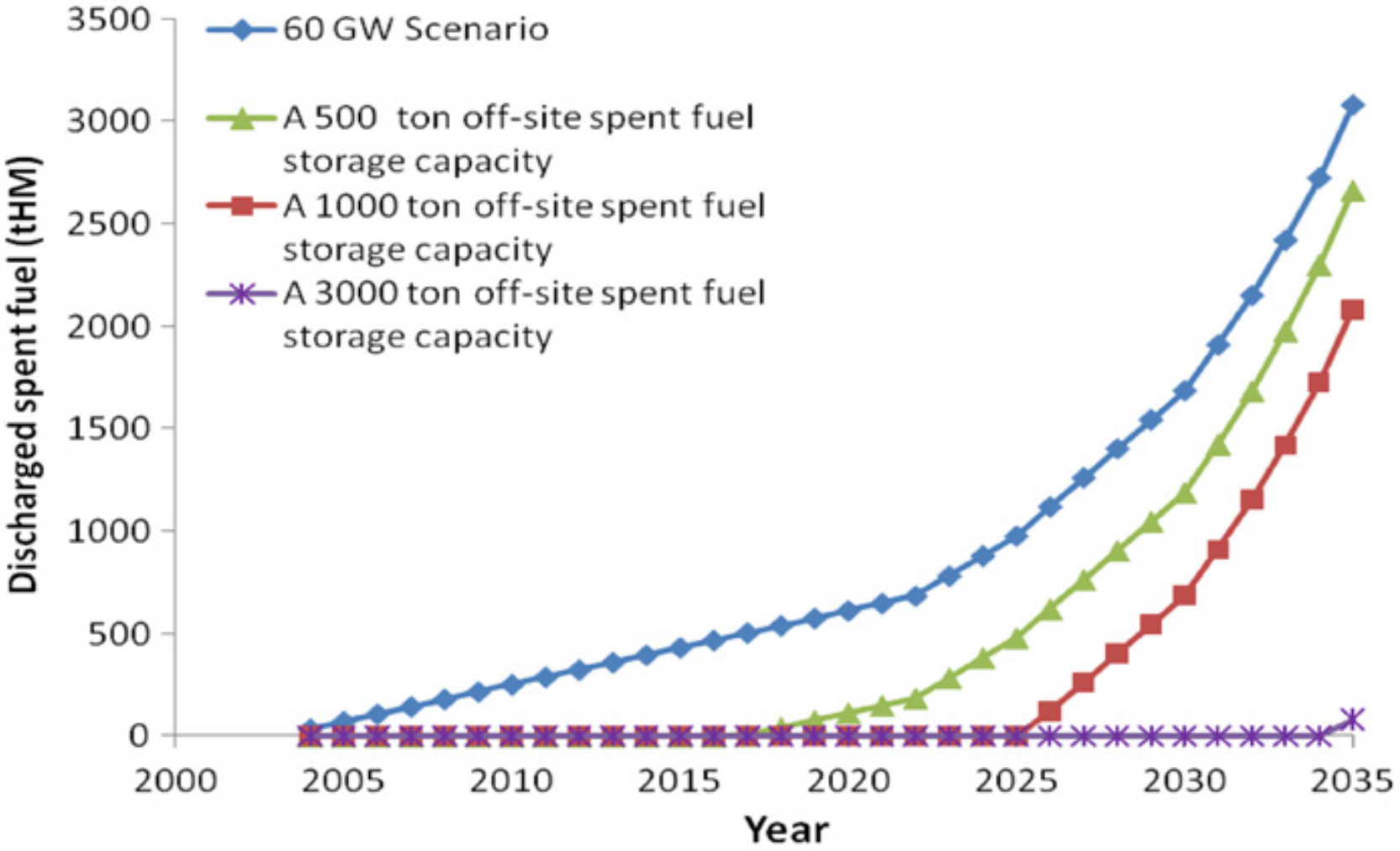
400
800 km
Urumuqi
Beishan site
Harbin
Sea of Japan
Beijing
Xi'an
Yellow Sea
Lhasa
Pacific Ocea
Shanghai
East China Sea
Guangzhou
South China Sea
South China Sea
Quaternary
Tertiary
Mesozoic
Palaeozoic
Proterozoic
Archaeozoic
Granite
Basalt
Basic-ultrabasic rocks
Fault

Section 3 :
China’s nuclear waste disposal: Future scenarios and Challenges

Future spent fuel management



Future spent fuel management (cont'd)

Offsite storage space (tons)	Estimate of when the storage will reach full capacity
500	2017
1000	2025
3000	2035

China will experience very little pressure to reduce the burden of storing spent fuel.

China's current fuel cycle program

- The reprocessing pilot site will be in operation in 2012 (50 tons/year)
- The China's experimental fast reactor connected to the grid (20 MWe)
- A potential commercial reprocessing site is under plan (Areva tech or domestic tech)
- A MOX pilot site is under construction

Future scenarios

- China will not experience pressure from spent fuel storage and China's ongoing R&D program on reprocessing. Therefore China will not view the deep geological disposal as a spent fuel storage tool in the near term.
- China will continue to generate HLW from its reprocessing R&D activities
- The potential commercial reprocessing site might not be in operation in the next 15 years.

Potential deep borehole disposal

- In China, deep borehole disposal was not considered as an option for HLW management and has not been studied closely
- Commercial drilling technologies in China allow a 4km depth and mainly focus on mining exploration
- In 2005, China's national drilling R&D project fulfilled a 5km deep borehole

Problems & Challenges

- An Incomplete regulatory system to regulate all nuclear activities
  - China needs an Atomic Energy Law to regulate all nuclear related activities
  - Currently, there is not any law to regulate nuclear waste management, disposal and spent fuel disposal fund imposition

Cont'd

- Insufficient attentions and financial supports on nuclear waste disposal R&D activities.
  - The budget on HLW R&D activities was relatively low comparing to other national energy projects
  - The HLW R&D program never been listed as a key national R&D program

Cont'd

- Insufficient public participation
  - the Chinese public seems to accept and embrace nuclear technologies before Fukushima for several reasons.
  - In the past, the Chinese public has not been an integral part of nuclear energy decision-making. This situation is changing.
  - The Chinese government will have to improve public participation to make the decision making system more transparent and enforce the regulatory system more effectively.

Cont'd

- Limited international cooperation on nuclear waste management and disposal
  - Participating international R&D projects
  - Communicating and collaborating with other nuclear states on geological disposal R&D