Application of LSC Techniques in Environmental Radiochemistry Research in China

Chunli LIU

Laboratory on Nuclear Environmental Chemistry
Beijing National Laboratory for Molecular Sciences
Fundamental Science Laboratory on Radiochemistry & Radiation Chemistry, College of Chemistry & Molecular Engineering
Peking University, Beijing 100871, PR China
Outlines

- Nuclear Industry in China
- Radioactive Waste Disposal in China
- HLW Disposal in China
- Application of LSC Techniques in Environmental Radiochemistry Research in China
Nuclear Industry in China

- China’s Nuclear Industry started from 1955
- The first Nuclear Weapon Test, 1964
- The first Hydrogen Bomb Test, 1967
- The first Submarine, 1971
- The first Nuclear Power Plant, 1991
- The first Aircraft Carrier, 2012
Nuclear Industry in China

- Currently, China’s total net electrical capacity, 32 GW, 37 reactors.

- Nuclear electricity production is 200kGW·h, 3.6%.

- In the middle of this century, the total net electrical capacity, 100 GW?

- Nuclear accidents with nuclear power plants must be taken into consideration.
Environmental Radiochemistry Research in China

- Environmental radiochemistry research in China started in 1980th;
- Currently focused on remediation of decommissioned nuclear facilities, radioactive waste disposal;
- Low & Intermediate level radioactive wastes are disposed regionally with near surface disposal facilities;
- High level radioactive wastes will be disposed in geological repositories.
HLW Disposal in China

Site selection--History

- 1986: Site selection started
- 1989: Six regions selected for high level radioactive waste repository
- 1990: Sub-area selection in Beishan area, Northwest China’s Gansu province
- 2000: Systematical site characterization in Northwest China’s Beishan area
- 2000/2012: Focused at Beishan Area, one site Policy (Following YM Model)
HLW Disposal in China

Discussions:

- 2005, 25 member “Expert Group” headed by Mr. PAN Ziqiang, an academician of Chinese Academy of Engineering, Chairman of the Committee of Science & Technology of the China National Nuclear Corporation (CNNC), and the President of Chinese Radiation Protection Society (CRPS);
- Nominated by the Chinese Atomic Energy Agency (CAEA)
HLW Disposal in China

Host Rock Selection Disagreement:

- CHILRAWD should be a government decided project just like that in USA when the US government decided the Yucca Mountain Project;
  - Since China is a developing country, it is difficult for the government to support scientists to carry out large amount of research activities for the selection of different potential disposal sites.

- CHILRAWD must a science-driven project, the selection of the potential disposal site must be based on science;
  - Necessary large amount of basic research must be carried out before the site is selected.
Beishan: the most potential site
HLW Disposal in China

- Beishan Site:
  - From the beginning of the 21 century, China’s geologists have for more than 15 years been carrying out geologic survey and mapping work at Beishan, Gansu Province.
  - They have drilled several boreholes of 400 to 700 meters deep and obtained various granite core samples.
  - Geochemists and radio-chemists have been performing basic research on the geochemical and radiochemical properties of the groundwater and the granite.
  - Dozens of millions of RMB has been spent in Beishan area.
HLW Disposal in China

- **Beishan Site:**
  - the average annual precipitation is about 60 mm;
  - the average annual evaporation is about 3,000 mm;
  - groundwater level at around 500 m from the surface;
  - the properties of the granite is acceptable as a host rock.

- **An important point:**
  
  these data are complete and sufficiently scientifically documented to allow the Chinese government to make decisions to construct a geologic repository at Beishan?
HLW Disposal in China

- **Yucca Mountain Lesson:**
  - The Yucca Mountain Project was shelved in 2010;
    - Chinese scientists and decision makers understand that one site policy is very dangerous!

- **More sites need to be investigated:**
  - In 2012, some other programs were approved to investigate more sites in China for the potential geologic repository.
HLW Disposal in China

- New Strategy:
- 12 sites are selected and investigated again;
- comparison of the 12 sites, in terms of including human activities, transportation, environmental protection, land use, social impact and public acceptance, geology, hydrogeology, future changes, geochemistry, engineering and construction conditions;
- 3 sites has been selected for pre-safety assessment;
- finally one site will be selected for the repository;
- The host rock includes granite and clay.
6 regions selected for repository
1 - South China; 2 - East China; 3 - Southwest China;
4 - Inner Mongolia; 5 - Xinjiang; 6 - NW China — Beishan area
Application of LSC Techniques

- Safety Assessment for the potential geologic repository needs many data;
- The migration of radionuclides in groundwater systems, the migration of radionuclides in surface soils, the transfer of radionuclides in ecosystems...;
- To understand the migration of radionuclides in groundwater systems, it is very important to understand the behaviors of some key radionuclides;
Application of LSC Techniques

- Tracing method is a powerful technique to obtain the groundwater flow field;
- Radionuclides $^3$H, $^{36}$Cl, $^{99}$Tc can be used as tracers at very low concentrations;
- The actuate determination of the concentration of these radionuclides needs badly the LSC technique;
- This LSC technique to determine the low concentration of β emitting radionuclides actually will be widely used in China in the area of environmental Radiochemistry in the following 20 years.
Research Activities at PKU

- Diffusion of Radionuclides in Beishan Granite;
- Molecular Dynamics Modeling of Uranyl Ions on the Clay/Water Interface;
- Development of Speciation Analysis Code, CHEMSPEC;
- Synthesis of Uranyl Crystals;
- Redox Behavior of Radionuclides in Beishan Groundwater.
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