A Big Progress at High Level Radioactive Wastes Disposal in China: From Follow Suit to Science Driven - 14064

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

ABSTRACT

China initiated High-level Radioactive Waste Disposal Program in 1985 in realizing the potential importance of safe disposal of high-level radioactive wastes (HLW) in the development of nuclear industry, especially in the development of nuclear energy in China. In the following year, 1986, a group named “Coordination Group on High-level Radioactive Waste Disposal” headed by Mr. G. Q. Xu at Beijing Institute of Uranium Geology was set up. Since then, research activities on site selection and geological survey in east China, south China, south-west China, north-west China had been conducted mainly by the Beijing Institute of Uranium Geology in cooperation with institutions and university research centers in China. In the year 2005, a 25 member Expert Group on High-level Radioactive Waste Disposal headed by Mr. Z.Q. Pan, 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), was nominated by the Chinese Atomic Energy Agency (CAEA) for providing technical and consulting support to CAEA in the long term planning and design, setting up of the targets at different stages, providing guidance on basic research programs and reviewing the important research projects of **C**hina’s **Hi**gh **L**evel **Ra**dioactive **W**astes **D**isposal (CHILRAWD) Program. In Feb. 2006, a planning and policy document for the R&D on Geologic Disposal of High-level Radioactive Wastes was jointly released by the Commission of Science Technology and Industry for National Defense, the Ministry of Science and Technology of the People’s Republic of China, and the State Environmental Protection Administration of China. This document outlines the research framework of the CHILRAWD. On the first annual meeting of the expert group held on October 27, 2006, the first 17 projects proposed by the institutions from the China National Nuclear Corporation, the Chinese Academy of Sciences and Universities, covering radionuclide migration, safety assessment methodology,

engineering design and site investigation were reviewed and approved. In this paper, the big progress for CHILRAWD will be presented and discussed.

INTRODUCTION

The safe disposal of high level radioactive wastes (HLW) and spent nuclear fuels (SNF) has been regarded as the back end of nuclear fuel cycle. The Fukushima accident happen in Japan following a magnitude 9.0 earthquake on 11 March 2011 has served to remind us that nuclear power cannot operate without a clear management and disposal strategy for back-end wastes(1). The Yucca Mountain project in the USA as the potential geologic repository for US “spent” nuclear fuel (SNF) and high-level nuclear waste (HLW) was shelved partly due to unresolved scientific and technical issues. One of the concerns was that UO_2 in SNF is not stable under the oxidizing conditions in Yucca Mountain and would convert rather rapidly to more soluble higher oxides (UO_2^{2+}). Substantial amounts of water exist in the pores and fractures of the volcanic tuff (2).

In the past 50 years or even more, scientists in the world have done a lot of laboratory and field work to understand the potential leaching characteristics of key radionuclides from waste containers and the migration behaviors of them in the backfilling materials and host rocks. The key radionuclides may include some weakly adsorbing radionuclides, such as ^{99}Tc($t_{1/2}$=2.13×10^5a; β-(294 keV);in the specie of $^{99}TcO_4^-$), ^{129}I($t_{1/2}$=1.57×10^7a; β^-(0.15 keV), γ(39.6 keV); in the specie of $^{129}I^-$),^{79}Se($t_{1/2}$=2.9×10^5a;β^-(0.16 keV); in the specie of $^{79}SeO_3^{2-}$) et al., transuraniums, such as ^{237}Np($t_{1/2}$=2.14×10^6a; α(4.788 MeV,4.771 MeV); in the specie of $^{237}NpO_2^+$), ^{239}Pu($t_{1/2}$=2.41×10^4a;α(5.156 MeV,5.144 MeV,5.105 MeV); in the specie of $^{239}PuO_2^+$), and ^{241}Am ($t_{1/2}$=432.7a; α(5.4857 MeV,5.4430 MeV);^{241}Am(III), and uranium. Due to their strong mobility in the backfilling materials and the host rocks of geologic repositories, long half lives and relatively large quantities in the HLW or SNF.

Scientists have done a lot of work about the behavior of these radionuclides in different environmental and geological conditions, and have collected a large amount of scientific data. These data are very important for predicting the sorption, diffusion and migration behaviors of these radionuclides in different hydro-geological conditions, and in the scientific community, high confidence have been existed, while lower confidence existed in the public.

China, the largest developing country in the world, has decided to develop nuclear energy for economic development and CO2 emission reduction. Currently there are 13 reactors in operation, and 28 reactors under construction. The total installed capacity would reach 58 GWe, and 30 GWe under construction in 2020 based on plans. Therefore, High Level Radioactive Wastes including SNF would come to 50,000 to 60,000 metric tons in the middle of this century.

According to the Law on Prevention of Radioactive Pollution: " high level radioactive waste should be disposed in a centralized geological repository". China plans to construct a geologic repository in the middle of this century.

THE DEVELPMENT OF CHILRAWD

China initiated its High-level Radioactive Waste Disposal Program in 1985 in realizing the potential importance of safe disposal of high-level radioactive wastes (HLW) in the development of nuclear industry, especially in the development of nuclear energy in China. In the following year, 1986, a group named "Coordination Group on High-level Radioactive Waste Disposal" headed by Mr. G. Q. Xu at Beijing Institute of Uranium Geology was set up. Since then, research activities on site selection and geological survey in east China, south China, south-west China, north-west China had been conducted mainly by the Beijing Institute of Uranium Geology in cooperation with institutions and university research centers in China. At this time, the high level waste disposal activities in other countries were very active, especially in USA. The Yucca Mountain project decided by the congress of the United State of America has much influence on the site selection activity in China. Finally, Beishan area located at the west part of Gansu Province in west China had been selected as the key research area for China's High Level Radioactive Waste Repository in 2003. Since then, considerable field and laboratory work has been focused on this area. Figure 1 shows the Drilling camp in snow at Beishan Area (3).

Figure 1 The Drilling Camp at Beishan Area

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On the annual meeting, there was disagreement regarding the selection of the host rock for the potential geologic repository in China. One group insisted that the CHILRAWD should be a government-decision project just like that in USA when the USA governments 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, while the others stand that CHILRAWD must a science-driven project, the selection of the potential disposal site must be based on science, therefore, necessary large amount of basic research must be carried out before the site is selected.

From the beginning of the 21 century, China's geologists have for more than 12 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 radiochemists 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. These investigations showed that the average annual precipitation in Beishan area is about 60 mm, the average annual evaporation is about 3,000 mm, with a groundwater level at around 500 m from the surface. In addition, the properties of the granite is acceptable as a host rock for a potential geologic repository. An important point at this stage is to decide if these data are complete and sufficiently scientifically documented to allow the Chinese government to make decisions to construct a geologic repository at Beishan?

NEW STRATEGY FOR SITE SELECTION IN CHINA

That the Yucca Mountain Project was shelved in 2010 tells Chinese scientists and decision makers that one site policy is very dangerous! In 2012, some other programs were approved to investigate more sites in China for the potential geologic repository. Currently, 12 sites are selected and investigated within 10 years, after comparison of the 12 sites, in terms of including human activities, transportation, environmental protection, land use, social impact and public acceptance, geology, hydrogeology, future natural changes, geochemistry, engineering and construction conditions, 3 sites will be selected for pre-safety assessment, and finally one site will be selected for the repository. The host rock includes granite and clay. This is a big progress in the process for the disposal of High Level Radioactive Wastes in China.

SUMMARY

The development of Chinese High Level Radioactive Waste Disposal was briefly presented. The policy on site selection from one site to one site (from 12 to 3, then to 1) is not only the change of numbers, but the change from Follow Suit to Science Driven. This will take the potential Chinese Geologic repository to a widely accepted not only by public but by science.

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