

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT:

9th International Conference on Chemistry and Migration Behavior of Actinides and Fission Products in the Geosphere—"Migration '03"
20.06002.01.071.009

DATE/PLACE:

September 21–26, 2003
Gyeongju, Republic of Korea

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Dates of Travel and Countries/Organizations Visited

September 21–26, 2003
Gyeongju, Republic of Korea

Author, Title, and Agency Affiliation

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Background/Purpose

The purpose of this trip was to attend and make a presentation at the subject conference. The presentation, titled "Assessment of the Potential Effects of Colloidal Radionuclide Transport on Nuclear Waste Repository Performance" and coauthored by W. Dam [U.S. Nuclear Regulatory Commission (NRC)], discussed the NRC approach to quantifying the risk significance of colloidal transport for the potential Yucca Mountain repository. We showed (i) results of preliminary simplified calculations, (ii) process model results, and (iii) the Total-system Performance Assessment 5.0 framework for colloidal effects. Attendance at this conference supported NRC evaluation of the ability of natural barriers at the potential Yucca Mountain repository to protect public safety and the environment by delaying radionuclide transport. In addition, attendance enhanced the international visibility of the NRC high-level waste program.

Abstract: Summary of Pertinent Points/Issues

I attended the subject conference to present a poster titled "Assessment of the Potential Effects of Colloidal Radionuclide Transport on Nuclear Waste Repository Performance." The poster, which discussed the NRC approach to assessing the risk significance of colloidal transport for the potential Yucca Mountain repository, was prepared as a Radionuclide Transport Key Technical Issue activity. This excellent conference provided an opportunity to learn about the most recent high-quality research relevant to issues of radionuclide release and transport in nuclear waste repositories. In addition, I gained a better understanding of the status and directions of waste disposal programs in a number of countries, especially in Western Europe and East Asia. Talks and posters emphasized the aqueous solution, surface species, and colloidal characteristics of actinides such as uranium, plutonium, and neptunium. A great deal of new data are becoming available, using increasingly sophisticated laboratory methods, that will allow better modeling of radionuclide release and transport. However, there still exists a need—as was stressed during a panel discussion on application to repository programs—for better integration of scientific results with performance assessment programs. In that regard,

my poster attracted particular attention because it provided an example of how one may make such a link.

Discussion

This report will note highlights of the technical sessions, rather than describing particular talks in detail, to give the reader an overall sense of the meeting. The conference opened on Sunday with plenary addresses by G. Choppin (Florida State University) on the history of the field of actinide chemistry and by C.W. Cho (Korea Atomic Energy Research Institute) on South Korea's nuclear energy and waste disposal programs. The technical program began on Monday morning with sessions on solubility/dissolution and geochemical and transport modeling. The opening talk by J.L. Kim (Forschungszentrum Karlsruhe, Germany) emphasized the importance to waste isolation of understanding actinide chemistry on the nanoscale with the use of sensitive techniques. Other talks of note addressed the effect of uranium-neptunium solid solution on neptunium release from waste (D. Rai, Pacific Northwest National Laboratory) and a comparison of streamtube and fracture network approaches to modeling transport in fractured rocks (J. Crawford, Royal Institute of Technology, Stockholm). B. Honeyman (Colorado School of Mines) opened the Monday afternoon session on the solid-water interface with a talk on upscaling laboratory sorption observations to the field scale, illustrating the potential effects on modeled transport of factors such as grain coatings and pathway sorption property heterogeneity. A notable example site discussed by Honeyman is the Naturita tailings facility in Colorado. The following session on radionuclide migration behavior featured a talk by T. Schäfer (Forschungszentrum Karlsruhe, Germany) on *in situ* testing of colloidal radionuclide mobility at the Grimsel crystalline rock site. Solutions of uranium, neptunium, plutonium, americium, strontium, and cesium were injected in to a fractured granite with and without added colloids. The results suggest the importance of colloidal effects for the mobility of trivalent (curium) and tetravalent (plutonium) actinides.

The Monday night poster sessions featured solution chemistry and solid-water interface topics. Several posters addressed actinide solubility/speciation (with a high number of posters addressing humic substance complexes), sorption, and waste form dissolution studies.

Tuesday morning's session on solid solution and secondary phases began with an invited presentation by R. Ewing (University of Michigan) reviewing secondary uranyl phases that may play a role in the alteration behavior of spent fuel in an environment such as Yucca Mountain's. Ewing made the point that the absence of such phases in performance assessment models can be attributed to the failure of researchers to provide modelers with simplified approaches. He added that if credit were taken for the potential containment afforded by secondary uranyl phases, model uncertainty downstream may be decreased. Two interesting presentations on secondary phase retention of actinides associated with glass waste forms followed (D. Bosbach, Forschungszentrum Karlsruhe, Germany, and K.S. Chun, (Korea Atomic Energy Research Institute). A talk particularly pertinent for the potential Yucca Mountain repository was then delivered by M. Douglas (Washington State University). This study provides persuasive, but not definitive, evidence for incorporation of neptunium in uranyl silicates that may form from alteration of spent fuel.

Two talks on colloidal actinides followed, the first addressing fundamental information on the formation and stability of true neptunium and plutonium colloids [R. Haire (Oak Ridge National Laboratory)] and the second discussing experiments on the formation and actinide binding

properties of aluminosilicate colloids [M.A. Kim (Technische Universität München, Germany)]. The first Tuesday afternoon session covered biological and organic material effects on radionuclide mobility, featuring an invited overview by K. Pedersen (Göteborg University, Sweden). Most of the effects, he noted, potentially contribute to radionuclide immobilization, but have not yet been incorporated into performance assessment models. The final oral session of the day included a discussion of the use of natural tracer profiles in strata to aid in upscaling laboratory results to the field scale [M. Mazurek (University of Bern)].

The Tuesday night poster session included my presentation, which, as discussed in the abstract above, attracted interest from those seeking to better incorporate their scientific results into performance assessment. An accompanying article has been submitted for journal publication. The session also included several posters on colloid characterization and radionuclide attachment, sorption experiments and models, radionuclide diffusion experiments, transport modeling, and natural analogs. Examples of posters potentially directly relevant to NRC/CNWRA concerns were: colloid diffusion experiments by U. Alonso (CIEMAT, Spain), colloid transport modeling by A. Möri (NAGRA, Switzerland), bacterial effects in uranium mine tailings by M. Merroun (Forschungszentrum Rossendorf, Germany), ion microprobe analyses of natural analog uranium minerals (K. Horie, Hiroshima University, Japan), and reviews of Spanish natural analog (P. Prado, CIEMAT, Spain) and performance assessment confidence building (J. Capilla, Technical University of Valencia, Spain) programs.

A Wednesday oral session on solution complexation featured a presentation by V. Vallet (Technical University of Munich) on a quantum chemical approach for modeling actinide compounds and a talk by L. Rao (Lawrence Berkeley National Laboratory) on experimental determination of uranium hydrolysis constants at elevated temperature. Such data may aid in prediction of actinide chemical behavior in a hot repository. The following sorption session included studies identifying actinide surface complexes spectroscopically. For example, R. Wilson (University of California Berkeley) discussed plutonium sorption on iron oxy-hydroxide, showing that sorbed plutonium is tetravalent irrespective of the starting solution valence states. A. Froideval (Institut de Recherches Subatomiques, France) characterized uranium complexes sorbed onto quartz under oxidizing conditions.

Thursday morning began with a session devoted to geochemical and transport modeling. J. Carrera (Technical University of Catalonia, Spain) discussed the challenges inherent in geochemical modeling of water mixing in the context of reactive transport, and C. Lomenech (Ecole des Mines de Paris) described an effort to create a web-accessible (<http://ctdp.ensmp.fr/>) thermodynamic database for solution chemistry and surface complexation calculations. The following session on redox and radiolysis included a talk on experiments and modeling of radiolytic UO_2 dissolution (B. Grambow, Université de Nantes, France) and a discussion of plutonium redox behavior in the presence of humic substances [C. Marquardt (Forschungszentrum Karlsruhe, Germany)]. Notable talks in the afternoon session on solubility and dissolution included a review of tetravalent actinide solubility and speciation [V. Neck (Forschungszentrum Karlsruhe, Germany)] that suggested an equilibrium relationship between dissolved and colloidal thorium. Relevant to the highly basic Hanford tank waste solutions, Z. Wang (Pacific Northwest National Laboratory) presented new results on curium and europium solution chemistry. Thursday's activities ended with a session on the solid-water interface that included a talk on how best to model surface complexation in a multicomponent system [N. Marmier (University of Nice, France)].

The first Friday session concerned actinide solution complexation, with subjects ranging from novel computational approaches [S. Tsushima (University of Tokyo)] to experiments on protactinium hydrolysis [B. Fourest (Institut de Physique Nucléaire, France)] to models of humic acid complexation [O. Tochiyama (Tohoku University, Japan)]. The final technical session of the conference, on Friday morning, covered large-scale international programs. T. Payne (ANSTO, Australia) first described results of the Nuclear Energy Agency's Sorption Modeling Project, in which NRC and CNWRA staff participated. The project found that surface complexation successfully simulates the important sorption phenomena, but that model results and parameters are typically site-specific. Next, F. Mompean (Nuclear Energy Agency, France) discussed the status of the Thermochemical Database Project, which produces comprehensive evaluations of data necessary for geochemical modeling of radionuclides. Notably, updated reports on uranium, plutonium, americium, neptunium, and technetium are now available, and reports on nickel, zirconium, and selenium are due next year. Finally, R. Klenze (Forschungszentrum Karlsruhe, Germany) described European Commission-sponsored joint research programs on actinide sciences.

The conference ended with a panel discussion on "Approaches to the Safe Disposal of Nuclear Waste: National and International Perspectives." The panel consisted of chairman I. Grenthe (Royal Institute of Technology, Sweden), P.S. Hahn (Korea Atomic Energy Research Institute), R. Ewing (University of Michigan), G. Chopin (Florida State University), T. Fanghänel (Forschungszentrum Karlsruhe, Germany), J. Hadermann (Paul Scherrer Institut, Switzerland), and P. Leconte (France). The key questions addressed by the panel were: (i) what is the role of universities? (ii) how is the knowledge produced by scientists used in the nuclear waste arena? (iii) how can we decide when a repository is "safe enough"? (iv) who has the responsibility for building confidence in a site or in the general notion of geologic disposal? Understandably, answers to these questions were elusive. Nevertheless, the discussion brought to the fore the need for scientists to better focus their results on the needs of waste programs in general, and performance assessors in particular. As one of the few representatives of the regulator in attendance, I was able to make the points that (i) in the context of Yucca Mountain regulations, basic science can contribute not only by directly providing data to performance assessments, but also by increasing understanding of the repository system, and (ii) the involvement of researchers from outside the U.S. Department of Energy complex is important for confidence building.

Pending Actions/Planned Next Steps for NRC

None.

Points for Commission Consideration/Items of Interest

None.

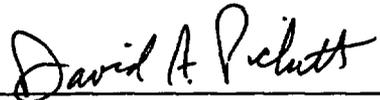
Attachments

None.

"On the Margins"

The value of staff attendance at such international conferences continues to be demonstrated, particularly as we approach the stage where we are learning more about how science is used in repository licensing.

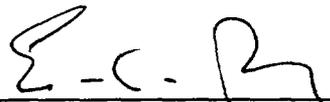
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