HLWYM HEmails

From: David Pickett
Sent: Monday, July 27, 1998 12:35 PM
To: jwb@nrc.gov
Subject: DOE Anthropogenic Analogues Workshop
Attachments: anthanal.wpd

Follow Up Flag: Follow up
Flag Status: Flagged

John,

I have attached an informal report on the subject meeting, which I attended in Las Vegas on July 20-21, 1998. Let me know if you'd like copies of any of the presentations referred to in the report.

It was a very interesting meeting, and it bodes well for Yucca Mountain application of flow and transport at Hanford, INEEL, and NTS _if_ work can be coordinated as promised and _if_ funding can be found. There is clearly a renewed interest in colloid transport - particularly in the unsaturated zone - among the YMP investigators, and the NTS folks want to get involved.

Please let me know if you have any specific questions.

David

Hearing Identifier: HLW_YuccaMountain_Hold_EX
Email Number: 697

Mail Envelope Properties (David Pickett19980727123500)

Subject: DOE Anthropogenic Analogues Workshop
Sent Date: 7/27/1998 12:35:00 PM
Received Date: 7/27/1998 12:35:00 PM
From: David Pickett

Created By: David Pickett

Recipients:
"jwb@nrc.gov" <>
Tracking Status: None

Post Office:

Files	**Size**	**Date & Time**
MESSAGE	653	7/27/1998 12:35:00 PM
anthanal.wpd	30324	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received: Follow up

DOE WORKSHOP ON ANTHROPOGENIC ANALOGUES TO FLOW AND TRANSPORT

July 20-21, 1998
Las Vegas, Nevada
David Pickett

SUMMARY

This workshop, sponsored by M&O contractor TRW at the request of the Yucca Mountain Site Characterization Project (YMP), focused on the possible use of anthropogenic analogues at the Hanford site, Idaho National Engineering and Environmental Laboratory (INEEL), and the Nevada Test Site (NTS) for building confidence in models of radionuclide (RN) flow and transport at Yucca Mountain (YM). The attached cover letter and agendas provide more detail on the purpose and objectives. Though billed as a single workshop, in execution the meeting consisted of two separate workshops attended by roughly the same group of people. The first was a familiarization exercise for YMP staff in flow and transport at Hanford and INEEL and the second was a discussion of YMP colloid research and the reported colloid-facilitated Pu migration at NTS. Both workshops ended with discussion groups organized by discipline, with the purpose of establishing agreement on the applicability of the analogues, the usefulness of available data, data needs and future plans, and establishment of points of contact. The participants stressed the need for communication and coordination among the different programs (previously lacking) to their mutual benefit. There was also a clear emphasis on the need for more information on unsaturated zone transport.

Below are more detailed notes on individual presentations. In general, the Hanford information was more phenomenological in nature; their flow and transport research program is not mature, and they expect to make great strides in the next five years. The Hanford presentations covered site description, observed radionuclide migration (chiefly ^{3}H, ^{129}I, ^{90}Sr, and ^{99}Tc), and preliminary vadose and saturated zone modeling. Aside from hydrogeologic differences (clastic sediments overlying basalt), other limitations to Hanford as an analogue to YM include the generally non-neutral and chemically complex nature of source fluids. The INEEL presentations revealed a more advanced program of field tests, monitoring, modeling, and lab experiments; again, direct hydrogeologic parallels with YM are lacking. The subsequent discussion groups (lab tests, field tests, modeling) seemed to agree that while only some of the flow and transport data from Hanford and INEEL would be useful for YM, experimental and modeling approaches, techniques, and technologies applied at those two sites may prove beneficial for YM efforts.

The colloids workshop on July 21 began with presentations of YMP's modeling treatment of colloids and discussions of pertinent YMP field and laboratory studies. These presenters included Paul Reimus on studies of saturated zone transport of synthetic colloids in the YM area and Ines Triay on LANL colloid/sorption work. Much of the discussion centered on the inadequacy of available colloid models (e.g., filtration). The final series of talks covered the discovery of saturated-zone Pu transport from a weapons test locale at NTS, and a description of nuclear weapons test phenomenology as an aid to understanding the observed transport. At the end of the day, discussion groups were again formed (lab/field tests, modeling) to discuss data needs and possible future tasks. Proposed experiments mentioned included vadose zone studies at Rainier Mesa and near the WINESKIN site, new sampling of bomb cavity waters and solids, and laboratory column studies. A key uncertainty looming over all these discussions was the availability of funds.

The information shared in the workshops was very interesting and useful for helping to define potential benefits to YMP. Perhaps the most important benefit was the opening of dialogue among DOE groups that haven't interacted much in the past; for example, at least one of the NTS researchers was not aware that Np transport was a YM concern and that Np measurements in NTS waters may be useful. The organizers will follow up with a summary of the workshops and the establishment of mailing lists of representatives from each of the sites grouped by discipline (i.e., like the discussion groups mentioned above). These groups will work (at a more detailed level than possible at the workshop) to formulate proposed tasks for FY99 that exploit the analogues for YM model confidence-building. As foretold by Wes, ensuring interaction between the separate groupings of experimentalists and modelers was not specifically addressed; however, it appears there will be some overlap in group memberships. It seems that the only effective way to ensure extensive tester/modeler interchange is to force them into the same room from time to time--such as happened at these workshops.

Following are descriptions of the individual presentations and discussions. Attached are copies of overheads from the talks, when available. I also have several pages of hand-written notes. I will circulate the meeting report when I receive it.

July 20

HANFORD

Jeff Serne (PNNL) - Hanford Description and Modeling
Serne first described the site's history and setting, and the nature of environmental contamination. Hanford 200 Area tanks, cribs, and trenches have leaked an estimated one million Ci of radioactivity into the ground, approximately 10 percent of which is in the groundwater (chiefly ^{3}H and ^{99}Tc). Serne was quick to add that projected doses from contamination are low. Groundwater monitoring--a large portion of which is CERCLA- and RCRA-driven--has produced thousands of data points in recent years demonstrating relatively minor levels of transport of ^{3}H, ^{90}Sr, ^{99}Tc, and ^{129}I. In contrast to YM, the unconfined aquifer consists of rather unconsolidated clastic sediments. Of the various topics covered, of particular interest was the description of transient spikes in ^{99}Tc contamination levels in 200 Area groundwater, inconsistent with past models based on porous flow. Serne also discussed the very limited data on and modeling of vadose zone transport, including application of the STOMP code (1D or 2D, porous media, "plug-flow" type model) to ^{137}Cs transport. It is notable that infiltration in the tank farms is strongly enhanced by the gravel fill emplaced above the tanks, and is modeled at 70 percent of precipitation. Serne finished with a discussion of composite dose modeling utilizing the STOMP and CFEST (3D unconfined aquifer model) codes.

Ron Schalla (PNNL) - Hanford Hydrostratigraphic Model
The title shown on the agenda is misleading: this talk was essentially a description of Hanford saturated zone hydrostratigraphy. The major transmissive unit is the Pliocene (?), largely fluvial Ringold Formation. Fracturing is uncommon and typically associated with lake deposits. Carbonate cementing is also minor. Flow in the main portion of Hanford is dominantly NW to SE toward the Columbia River. It does not appear that the underlying Columbia River basalts are important to transport. (Note: copies of overheads were not provided.)

Hanford Discussion
In response to a question from Abe van Luik (DOE), Serne described recent detection of Pu in a Hanford groundwater sample at fCi/L levels; filtration tests are underway to identify the nature of the Pu. He also

mentioned historical observations of limited Pu vadose zone migration associated with acidic, organic complexant-rich releases. Arend Meijer (LANL) asked if there were opportunities at Hanford to look at RN transport where water chemistry is less affected by high pH, low pH, and/or organic-rich wastes, i.e., near-neutral conditions more analogous to YM. Serne said that there should be several sites to consider. Another question raised the possibility of using N Reactor fuel rod storage pools as source analogues. Finally, Serne said that plans for FY99 include adding consideration of dual-porosity flow to groundwater modeling, funds permitting.

INEEL

Tom Stoops (INEEL) - Overview of Environmental Restoration (ER) Sites
Stoops described the CERCLA-driven INEEL ER program, listing the various areas and contaminants of concern. Key radionuclide contaminants are ^{14}C, ^{90}Sr, ^{137}Cs, ^{129}I, and ^{3}H, found in groundwater and/or the vadose zone. A Pu plume has been observed in the vadose zone at one location in the Radioactive Waste Management Complex, associated with carbon tetrachloride contamination; Am has also been detected. These were not, however, observed in the saturated zone.

Tom Wood (INEEL) - Vadose Zone Data and Research
This talk began with a description of INEEL subsurface stratigraphy, primarily composed of basalts with minor interbedded sediments. The aquifer is 200-700 feet deep and is characterized by relatively rapid flow rates. In contrast to Hanford, the vadose zone at INEEL has been the subject of intensive research and monitoring for an extended period. Projects have included infiltration and tracer tests, fractured rock characterization studies, and instrumentation development. More recent CERCLA-driven work has included the Large Scale Infiltration Test, which traced radionuclide migration from a flooded 6.5 acre basin. Tests and instrumentation have resulted in a large data set covering information such as water levels, moisture content, perched water zones, flow, contaminant distribution, and stratigraphy. Particularly emphasized was an advanced deep tensiometer useful for monitoring perched zones. Wood also discussed the "chaotic-dynamical" approach to vadose zone flow in basalts, applied in conjunction with small-scale field infiltration tests showing transient flow behavior. There is also a test facility for assessing the performance of concrete barriers.

Jim Navratil (INEEL) - Plutonium Speciation/Solubility Experiments
The objective of this research is to understand parameters controlling Pu mobility in INEEL groundwaters. The main topic was a series of a column experiments in which Pu-spiked synthetic perched water was passed through columns of basalt and sediment. The results suggest that multiple Pu species play significant roles in transport. There is evidence of colloidal transport in the experiments, perhaps related to Pu(IV) polymer. These observations argue against the use of single K_d values in Pu transport modeling. Navratil then discussed attempts to reconcile thermodynamic Pu speciation/solubility calculations with the column test results. This work is ongoing, and the investigators seem to be aware of the difficulties of conducting well-characterized Pu experiments.

Annette Schafer (INEEL) - Overview of Vadose Zone Modeling
Schafer discussed the motivations, objectives, approach, results, and limitations of vadose zone modeling at INEEL. The dual permeability/porosity model is three-dimensional and multiphase, and accounts for spatially variable hydraulic and geochemical characteristics (which differ greatly between basalt and sediment strata). As implied above, there is an extensive and mature data set available for constraining and testing models. For example, field observations have demonstrated the importance of sedimentary layers to the formation of, and lateral flow in, perched zones. Application of the model has identified data

needs in areas such as: small-scale variation of hydraulic properties; moisture content measurements; and the relationship between permeability, saturation, and reactive surface area. The geochemical component of the modeling has not yet incorporated more realistic processes such as colloid transport and non-equilibrium; these approaches may help understand observed Pu transport, for example.

Boris Faybishenko (LBNL) - Unsaturated Flow in Fractured Basalts
This talk (not on the agenda) was highly theoretical and difficult to follow. The main theme was the correct interpretation of field data on unsaturated zone flow, with emphasis on spatial scale variation. An example of the type of uncertainty addressed is whether tensiometer measurements indicate water pressure in the matrix or in the fracture.

HANFORD-INEEL DISCUSSION GROUPS

Following the INEEL presentations, meeting participants were split into three discussion groups: lab tests, field tests, and modeling. The purpose of the groups was to answer a set of questions about the application of the Hanford and INEEL analogues to YM and to form working groups for follow-up action. The questions (shown on the attached agenda) briefly are: (i) What waste issues are common among the sites? (ii) What information is applicable to YM? (iii) What limited new data could come from these sites? (iv) How would YMP use the information? (v) What could be done in the FY99-02 frame? (vi) What would be the scope of work? I sat in on the Lab Test group, which was skewed toward geochemistry. The group agreed that the three sites shared many lab-oriented issues pertinent to waste isolation (e.g., K_d, colloids, solubility, equilibrium versus kinetics). Furthermore, while specific data may not be transferable, experimental approaches were; much could be gained by applying similar approaches to the different environments. Use of the shared and new information would be geared toward testing models, making them more realistic, and using them to achieve "stakeholder buy-in." The group's "product" would be development of a common experimental approach to solving issues of chemical retardation, speciation, and source term. Key members would be Navratil (INEEL), Joe Thompson (NTS), Triay (YMP), and Serne (Hanford).

The Field Tests group came to similar conclusions regarding the application of the Hanford and INEEL analogues. Key issues included fracture network characterization and instrumentation technology. Significantly, they intend to compile a report containing all pertinent rock and hydrologic data from the three sites. (I am a little skeptical that they could pull this off.) Key Field Test group members are Eric Sonnenthal (LBL), Wood (INEEL), Serne (Hanford), and Thompson (NTS). The Modeling group established that common issues were preferential pathways, perched water, and fracture- versus matrix-dominated flow. The modelers see many opportunities for comparing field test results from the sites with respect to how they affect model inputs. They mentioned several examples of useful lab and field test results (e.g., colloids, infiltration) that could be applied to model confidence-building; this is promising with regard to tester-modeler interaction.

July 21

COLLOIDS IN YMP

Christine Stockman (SNL) - Colloids in YMP TSPA-VA
The colloids workshop began with a discussion of how colloid transport is incorporated into TSPA-VA. At this time, colloidal transport is considered only for plutonium. Colloids are categorized in the model as

clays, iron oxide corrosion products, spent-fuel waste form, or glass waste-form. If colloids do carry significant amounts of radionuclides, the key issues for colloid transport are stability and reversibility. Colloid concentration (i.e., stability) is calculated in the model as a function of ionic strength using empirical data. Partitioning of Pu onto colloids is modeled on laboratory results. Two different models have been investigated for colloid transport. In the reversible model, Pu is sorbed onto colloids according to an equilibrium K_C (analogous to K_d). The colloid fraction is treated as an aqueous species and slow desorption (observed in the laboratory) is accounted for by increasing K_C. In the irreversible model, a defined fraction of Pu (based on NTS results and accounting for sorption and filtration) is attached irreversibly to colloids and then behaves as a nonsorbing tracer. The top dose realizations come from cases of reversible transport. An audience member commented that this relatively complex transport modeling approach is built on a very flimsy foundation of data and theory. It was suggested that a better approach may be to simply apply sensitivity analyses to Pu transport parameters, obviating the need for confidence in the colloid model.

Maureen McGraw (LANL) - SZ Pu Colloid Transport Model Development
McGraw described progress and plans in developing a model for fractured, saturated-zone colloidal Pu transport. To date, a sensitivity study has been conducted on three key mechanisms: Pu-colloid sorption, Pu-matrix sorption, and colloid filtration. McGraw then discussed the importance of including aqueous Pu oxidation/speciation effects (which has not yet been done), and then described a traditional theoretical approach to colloid filtration that is unsuitable for long-term transport modeling. Rather, colloid filtration modeling will be based on more empirical attachment/detachment rates which include size and chemical effects. Andy Wolfsberg finished the talk with a brief example of the incorporation of colloids into a three-dimensional transport model. The question-and-answer session after this presentation raised several important issues. Ines Triay pointed out that it isn't really critical to apply redox constraints to Pu speciation because lab and field observations suggest that longer-term aqueous Pu behavior is always controlled by the Pu(IV) species. Other issues were the potential for colloid resuspension under transient conditions, element competition, and whether colloids are transported in the unsaturated zone under any condition other than episodic flow.

Paul Reimus (LANL) - Field Colloid Tracer Studies
This very interesting talk was concerned with field studies of synthetic (polystyrene) colloid transport in saturated, fractured rock; included were tests at the C-Wells at YM. The colloids are detectable to less than 100 per ml and are injected into the saturated zone along with non-sorbing tracer solutes. The colloids are detected in water pumped from a second well. The C-Wells data show two peaks in solute and colloid concentration at the receiving well, suggestive of two different transport pathways (i.e., with different hydraulic properties). Also, the colloids were attenuated by around an order of magnitude relative to the solutes, although some colloids did arrive before solutes. Knowledge of colloid size and the different solute diffusivities allows curve-fit modeling of pathway hydraulic properties. Reimus stressed that the long peak tails suggest matrix diffusion for the solutes and reversible filtration for the colloids. He then discussed results of similar tests at NTS (tuff) and California (granite), and used the results in concert with the C-Wells results to look at the sensitivity of filtration parameters to distance and time traveled. Future tests at C-Wells will be complemented by lab transport and visualization studies.

Ardyth Simmons (LBNL) - Jiamin Wan's Work on Modeling UZ Colloid Filtration
Simmons briefly reported on Wan's "film-straining" mechanistic colloid model and related lab tests. This model is an answer to the inapplicability of traditional filtration models to the unsaturated zone. "Film-straining" refers to the behavior of colloids in a water film coating a mineral surface. A colloid with a diameter greater than the film thickness will be relatively immobilized, while smaller colloids will flow

along the film and be more rapidly transported. The model is well supported by laboratory unsaturated column studies. Future tests with actual YM tuff are planned. One audience member wondered about the response of film thickness (a key model parameter) to continuous versus episodic UZ flow.

Ines Triay (LANL) - Data Adequacy for Colloids at YM
Triay gave an overview of the YMP view of available field and laboratory data that constrain knowledge of colloid transport. This talk was apparently identical to that given by Triay at the March 1998 PA technical exchange, so I will omit details. Included were discussions of observed Pu migration at NTS; in Triay's view, the conditions at NTS are different enough from a YM repository that the main utility of the discovery is in legitimizing application of colloid transport in PA--not in providing specific data. The use of forward and reverse colloid sorption rates was stressed, and new data on desorption rates are forthcoming. After the talk, the issue of dynamic resuspension of colloids due to episodic flow was once again raised; I believe the questioner was the NWTRB representative, but I did not hear his name.

COLLOIDAL Pu AT NTS

(Note: Copies of overheads were not provided by the final four speakers.)

Joe Thompson (LANL) - Introduction to Radionuclide Transport at NTS
Thompson provided a historical overview of the Radionuclide Migration (RNM, now called HRMP) program at NTS, under which Pu colloidal transport was discovered. General observations included: (i) RN movement is, in part, intrinsically related to shot phenomenology (e.g., prompt injection, gas species), (ii) only a very small proportion of the RN in underground test sites had migrated, despite the great disturbance in cavities, (iii) there has been no evidence of aquifer contamination, and (iv) there is no information on vadose zone transport. He also stressed the glaring lack of interprogram cooperation (YMP-NTS) in the past.

Annie Kersting (LLNL) - Observation of Pu Colloid Transport at NTS
This was a more technical talk on the observation of colloidal Pu (and Co, Cs, and Eu) associated with the BENHAM test site. The colloids have been identified as consisting of illite, the zeolites mordenite and heulandite, and cristobalite. Various tests have demonstrated the association of Pu with the colloids. There appears to be no strong evidence against prompt injection as a mechanism for delivering the Pu such a distance (1.3 km) other than the firm belief of all investigators that it is highly unlikely. Observation of lower activities deeper in the well and the absence of RN from the shallower TYBO site suggest groundwater upwelling. Future research may focus on the unsaturated zone and on more specific information on RN colloid origin.

Dave Smith (LLNL) - Other NTS RN Work
Smith gave a more general presentation on colloidal RN-related work at NTS. He noted that the inventory of RN below the water table at NTS is about 10^8 Ci. The cavity fluids and solids are important to understanding colloid source term, and there is currently an effort to recover them from the CHESHIRE site; such work may be extended to BENHAM, funds permitting. Concerning the unsaturated zone--which participants all agreed should be a focus of followup work--studies of possible colloid migration at Rainier Mesa have been proposed for FY99, taking advantage of the extensive access there. Smith also mentioned ion microprobe studies that have shown the position of sorbed RN on zeolite surfaces.

Tom Kunkle (LANL) - Nuclear Test Phenomenology at NTS

The purpose of this entertaining talk was to familiarize participants with the methodology of underground bomb tests and the physical processes taking place during and after a test. Of note are the thorough mixing of bomb debris with molten rock, the typical limiting of prompt injection and rock fracturing to less than two cavity radii due to rebound stresses, cavity collapse phenomena, and the possibility that prompt injection could be enhanced by density contrasts in rock strata (BENHAM?).

COLLOIDS DISCUSSION GROUPS

Two discussion groups--lab/field tests and modeling--were formed to again discuss possible inputs to FY99 planning for both YMP and NTS. The key questions posed were: (1) What NTS information is applicable to YM? (2) What additional NTS data could be collected to strengthen colloid models? (3) How can YMP and NTS planning efforts be integrated? I sat in on the lab/field test group, which actually focused on question #2 to the exclusion of the others. Areas of interest to YMP for future work specifically mentioned were: searching for colloid transport from unsaturated zone bomb tests at Rainier Mesa and the underground WINESKIN site (located, unlike most tests, in the unsaturated zone), lab column studies using the set-ups already in existence for solute transport work, sampling of bomb cavity waters and glasses, and field redox measurements. There were serious reservations about the availability of funds for some of the more ambitious tasks (e.g., cavity sampling).

The modelers group pointed to much the same set of potential data applications. They pointed out that at Rainier Mesa it may be possible to look for transport along paths that do and do not encounter perched zones. It was mentioned that the NTS workers have not had to pay much attention to the unsaturated zone and that is why there is much to be done there. The focus will apparently be on transport model validation rather than new model development.

Dixon wrapped up the meeting by saying that he and Simmons will distribute a meeting report and teleconferences will be arranged for the discussion groups. The focus of these followup discussions will be on FY99 research plans. Again, no specific mechanisms were emplaced for ensuring close tester-modeler cooperation. However, inter-site cooperation was well stressed, with the Hanford and INEEL participants also involved in the colloids discussions.