CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: 8th DECOVALEX-2015 Workshop

DATE/PLACE: October 13–16, 2015
Wakkanai, Japan

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PERSONS PRESENT: Randall Fedors (NRC) and Stuart Stothoff (CNWRA) participated in the 8th Workshop of the DECOVALEX-2015 project.

BACKGROUND AND PURPOSE OF MEETING/TRIP: The workshop was held on October 13–16, 2015, in Wakkanai, Japan. The **De**velopment of **Co**upled Models and Their **Val**idation against **Ex**periments (DECOVALEX) project is an international collaboration focused on modeling thermal-hydrological-mechanical-chemical (THMC) processes associated with the geologic disposal of high-level waste and spent nuclear fuel. The purpose of the workshop was for participants to interact to identify issues and learn from the variety of approaches taken by the different teams. This was the final workshop of the DECOVALEX-2015 project.

SUMMARY OF ACTIVITIES: The NRC and CNWRA staffs' participation in the 8th DECOVALEX-2015 workshop provided an opportunity to interact and discuss other organizations' approaches and progress in modeling field experiments encompassing near-field coupled THMC processes. The workshop agenda is included as an attachment. The activities at this workshop included (i) discussion on approaches and progress by each participant for the relevant portions of the five tasks, (ii) informal interactions between presentations and group discussions, and (iii) a field trip. Discussions of research progress for DECOVALEX-2015 tasks provided a better understanding of the technical challenges in simulating near-field conditions and the advantages and disadvantages of several alternative approaches.

Involvement with DECOVALEX allows the staff to leverage expertise from waste disposal programs from many countries in understanding complex near-field processes and issues in a variety of geologic environments. Leveraging international experience will help the NRC and CNWRA staff understand important technical and performance issues that may influence planning and preparation for future regulatory developments as the U.S. national waste policy and program evolve.

The continued development of modeling tools validated against large underground experiments will, in subsequent years, enable staff to provide insights on the importance of coupled processes on repository performance for geologic disposal. The NRC and CNWRA staffs will continue to develop the modeling tools to analyze coupled processes in the near-field of repositories in the saturated zone.

Use of these data could guide and constrain scenario modeling of coupled THMC near-field processes. In addition to the continued development of modeling tools and identification of required constitutive relations for near-field processes, the NRC and CNWRA staff will continue to use information leveraged from international interactions to refine near-field abstraction approaches and data for performance assessments.

Trip Details

Five tasks were agreed upon at the 1st DECOVALEX-2015 workshop in April 2012, called A, B1, B2, C1, and C2. The NRC staff participated in Tasks A, B1, and C1. CNWRA was tasked to support NRC with Task B1. All staff followed discussions for Tasks B2 and C2 to gain insights from the efforts and approaches of other DECOVALEX participants. Because of the open and collaborative environment in DECOVALEX, the staff is able to gain insights from the discussions pertaining to the other tasks. Four of the tasks involve modeling of experiments at underground facilities and the fifth task involves modeling of a complex laboratory experiment.

The following tables provide information related to the task description, participants, discussion points, future work, and action items specific to NRC/CNWRA for each task. The acronyms used in the tables for each task are as follows:

BGR	Federal Institute for Geosciences and Natural Resources, Germany
CAS	Chinese Academy of Sciences
CEA	Commissariat à l'Energie Atomique, France
CIMNE	Centre International de Métodes Numèrics en Enginyeria, Barcelona, Spain
CNSC	Canadian Nuclear Safety Commission, Canada
DOE	Department of Energy, USA
ENSI	Swiss Federal Nuclear Safety Inspectorate, Switzerland
IC	Imperial College of London, UK
IRSN	Institut de Radioprotection et de Sûreté Nucléaire, France
JAEA	Japan Atomic Energy Agency
KAERI	Korea Atomic Energy Research Institute, Korea
KINS	Korea Institute of Nuclear Safety
KRMC	Korea Radioactive Waste Management Corporation
KIGAM	Korea Institute of Geoscience and Mineral Resources
KTH	Royal Institute of Technology, Sweden
LBNL	Lawrence Berkeley National Laboratory, USA
NAGRA	Nationale Genossenschaft für die Lagerung radioaktiver Abfälle, Switzerland
RAWRA	Radioactive Waste Repository Authority, Czech Republic
RWM	Radioactive Waste Management, UK
SNL	Sandia National Laboratories, USA
SNU	Seoul National University
TUL	Technical University of Liberec, Czech Republic
UFZ	Helmholtz Centre for Environmental Research, Germany
UPC	Universitat Politècnica de Catalunya, Spain
UGN	Institute of Geonics, Science Academy of Czech Republic
UoE	University of Edinburgh, UK
Quintessa	Quintessa Ltd., UK

Task A	
Brief Description of the Overall Task	SEALEX experiment at Tournemire underground research facility in France, developed by IRSN. The task focus is on hydromechanical performance of bentonite seals for horizontal emplacement boreholes.
Brief Description of the Current Steps, Task A (Completed Steps Are Included. Last Item Listed is the Current Step)	STEP 0—Modeling of bentonite-sand mixture hydromechanical behavior and parameters identification from various laboratory tests such as (i) water retention curves, (ii) infiltration test under constant volume condition, and (iii) swelling and compression tests under suction control condition. STEP 1—Blind prediction of laboratory 1/10th mock-up test using parameters obtained from Step 0. Simplifications used for the mock-up test are the elimination of bentonite-host rock interaction and axisymmetric geometry. The initial gap is employed at start of test. STEP 2—Modeling the hydrological response of the host rock around water injected under a pressure head into a borehole section isolated with a stainless steel packer. STEP 3—Modeling of one of the SEALEX tests, PT-A1. Field scale test of bentonite/sand seal with asymmetrical technological gap and injected water to enhance resaturation rate
Participant/Funding Organization	Software Used
RAWRA/UGN	COMSOL
Quintessa/RWM	OpenGeoSys and QPAC
NRC	xFLO-FLAC
CNSC/IRSN	COMSOL
BGR-UFZ	OpenGeoSys
IRSN	CODE-BRIGHT
Main Conclusions and Issues	1. Step 0—HM modeling of lab tests for the bentonite/sand mixture. Compression tests reproduced by all teams, but infiltration test still causes some difficulties; problems with matching the entire suite of curves, which probably illustrates the importance of free swelling and of hydromechanical coupling in general. Curiously, hydrologic-only calibrations fit just as well as the hydromechanical-coupled fits. Mixing of retention curves in the other parts of Step 0 may have caused some problems; mixing of 1.67 and 1.97 g/cm^3 materials. 2. Step 1— HM modeling of the 1/10th mockup lab test. The gap and change in boundary condition for the mock-up test are challenging aspects to this problem. Continuous change in properties from initial dry density material (1.97 g/cm^3) to a material comparable to 1.67 g/cm^3 (dry density)

as the gap is filled suggests possible approach is to make hydromechanical properties a function of void ratio. A couple issues in results are:

- Behavior at 0 (low) suction, gel formation, flooding of gap, and spatial imbibition into sample
- Over-prediction of Phase 1 water injected
- Difficulty with transition between Phase 2a and 2b

3. Step 2—Modeling the host rock during the WT-1 *in situ* flooding test. Teams addressed important aspects discussed by teams at the previous workshop:

   - Location (borehole wall or gallery wall) for the atmospheric boundary condition, and the need to incorporate steady or seasonal fluctuation of temperature and relative humidity at that boundary condition. *Updated modeling suggests that the most appropriate approach uses the gallery wall for the pressure condition and accounts for seasonal fluctuations.*
   - Importance of incorporating borehole and/or gallery excavation damage zone in models, and should the properties evolve as rewetting occurs? *Updated pressure modeling suggests that the EDZ heals after resaturation (permeability drops by almost a factor of 5 over a year).*

4. Step 3—Modeling the PT-A1 test, which features a 60-cm diameter horizontal drift with cylindrical bentonite disks initially compacted to 1.97 Mg/m^3 resting on the bottom of the drift, sealed with water-tight packers, and flooded with water, ultimately yielding a saturated bentonite density of 1.67 Mg/m^3. IRSN provided an updated assessment of the initial water injection to reconcile the initial 80 kg of injected water, which was previously thought to be explained by the technological void space (space between bentonite plug and host rock) in the 6th workshop. It was also noted that there was a gap between the downstream lid and the rock, and other minor gaps within the bentonite plug that may have also filled during the initial pulse of water. Teams presented modeling results for the PT-N2 and PT-A1 tests using 2D axisymmetric and 3D (isotropic) HM models in the 6th workshop. Some of the sensors in the bentonite responded asymmetrically, suggesting rapid saturation. Participants speculated that perhaps a seam between bentonite disks was a flow pathway.

   The 8th workshop focused on final modeling results for Step 3 (i.e., modeling the PT-A1 Test) and presenting conclusions based on all steps in the task. The teams used a combination of elasto-plastic and elastic models. The Task Lead summarized the main conclusions as follows:

   - Hydrology: The retention curve for bentonite should account for changes in dry density (or porosity). The permeability–saturation relationship should also account for changes in dry density (or porosity). Laboratory characterization studies should include test cases at varying dry densities. Numerical models using the Richard’s equation to model flow was found to be appropriate, provided vapor diffusion was included in the analysis.

Task A	
	• Geomechanics: The bentonite-sand mixture demonstrated an elasto-plastic response, although both elasto-plastic and nonlinear elastic models provided reasonable predictions. The numerical models had to incorporate swelling strain for the bentonite. Heterogeneity between geomechanical sensors in analogous locations (e.g., between ends, or radial positions) was problematic; some teams used average results, while other teams selected a particular sensor to match. • Representation of the technological void is important in modeling short term behavior seals modeled in this task. Teams that accounted for the formation of gel at the bentonite surface matched the observations better. Additional tests are required to characterize gel behavior.
Future Work	The team planned to finalize the report by 11/30/2015, to be reviewed by some of the funding organizations involved in this task (including NRC).
Action Items for NRC Staff	Staff contributions for Task A in 2014 and 2015 were limited by Yucca Mountain responsibilities. NRC staff have provided several rounds of comments on the final Task A report. Staff comments on the Steps 0 and 1 journal paper are pending.

Task B1	
Brief Description of the Overall Task	The HE-E experiment was run by a consortium of European Union countries at Mont Terri underground research laboratory in Switzerland. The experiment focuses on thermal-hydrologic-mechanical performance of two types of bentonite buffers surrounding a horizontally-emplaced analog waste package heated up to 140 °C in a low permeability argillaceous host rock.
Brief Description of the Current Task (Completed Steps Are Included. Last Item Listed is the Current Step)	STEP 1a—Opalinus Clay study: Numerical modeling of the thermal-hydrological-mechanical behavior in Opalinus Clay host rock at the HE-D heater test in the Mont Terri tunnel system. STEP 1b—Buffer material study: Numerical modeling of CIEMAT column cells with focus on process understanding and parameter determination. The objective of this step is to calibrate the constitutive relationships for the bentonite pellet mixture based on back analysis of the column tests and literature study. The main parameters are associated with moisture retention curve, dependencies of thermal conductivity and water permeability on degree of saturation, and mechanical constitutive relationships. STEP 2—HE-E predictive modeling: Numerical modeling of the thermal-hydrological-mechanical behavior in the swelling bentonite buffer and Opalinus Clay host rock at the HE-E heater test in the Mont Terri tunnel system.

Task B1	
Participant/Funding Organization	Software Used
UFZ /BGR	OpenGeoSys
CAS	Elasto-Plastic Cellular Automaton (EPCA) 3D
LBNL/DOE	TOUGH-FLAC
ENSI	OpenGeoSys
CNSC/IRSN	COMSOL
JAEA	THAMES
KAERI	FLAC
CNWRA/NRC	xFlo-FLAC
Summary of Discussion	1. All teams presented their results for the HE-E test. Some teams revisited the column cell test, reporting improved model behavior regarding the THM processes in the column cell material. 2. Most of the teams (except CNWRA) used a 3D model for the HE-E test. LBNL used both a 2D plane strain model on a cross section and a 3D model. LBNL and CNWRA used multiphase flow, whereas other teams used the Richards Equation approximation (single phase flow). 3. Though some teams modeled the sand-bentonite and granular bentonite sections, the focus of discussion was on the granular bentonite section. 4. The temperature, relative humidity, and pore pressure measurements in the granular bentonite, bentonite blocks, and Opalinus Clay were compared to the model estimates for two cases. The first case used model input parameters that were not calibrated but were based on the column test (for granular bentonite), HE-D test (Opalinus Clay), and previously published reports (for bentonite blocks). The second case used calibrated input properties. Only a few groups reported results for the second case. 5. The predicted temperatures matched the observations in general. However, most of the model predictions showed smeared relative humidity values compared to the observed values. CNWRA/NRC results suggest that insufficient grid resolution will produce smearing. 6. The final task was to evaluate rewetting of the buffer for two scenarios: (i) heating continues indefinitely while maintaining a temperature of 140 °C at the heater and (ii) heating is stopped at a specific time in the future. The prediction included the time required for the buffer to be saturated and heater power. Only BGR and CNWRA/NRC completed the final task.

Task B1	
Future Work	1. HE-E paper: Teams are to give feedback to Benoit Garitte once the draft is available. It is unclear when the paper will be available. The lead author for the HE-D paper is Dr. Graupner (ENSI) and for the Column Test paper is Dr. Nguyen (CSNC). 2. Final report: Teams are to give feedback to Garitte once the draft is available. It is unclear when the report draft will be available; as of the end of November 2015 the task leader had not sent a draft for all team members to review.
Action Items for NRC/CNWRA staff	1. Provide input to the HE-D, Column Test, and HE-E journal papers once the drafts are available. 2. Provide input to the final report when available.

Task B2	
Brief Description of the Overall Task	“EBS” experiment planned at the Horonobe Underground Research Laboratory in Japan. The experiment focuses on THMC processes in a bentonite buffer surrounding a vertically emplaced analog waste package heated to 100 °C in an argillaceous host rock of moderate permeability. Salt accumulation is the chemical process of interest. An emphasis is comparing model predictions using identical parameters to the extent possible.
Brief Description of the Current Task	Step 0—Preparation phase. Literature review and analyses of laboratory test data, especially for backfill. Step 1—Code comparison analysis. Set up input data for two analyses; one analysis to support sensor layout, and one analysis to predict long-term behavior. Step 2—Prediction analysis. Run model analyses, comparing with selected sensor data from the field experiment. Step 3–Sequence of the Horonobe EBS test, which includes (i) excavation of the experimental gallery, (ii) opening the test pit, (iii) emplacing the buffer and backfill material, (iv) plugging, (v) stopping the pump (used to remove seepage), and (vi) initiating heating. The temperature was monitored at top, middle and bottom of the simulated waste container. The pore pressure was monitored at the center of the bottom of the test pit in the sand layer.
Participant/Funding Organization	Software Used
JAEA	Couplys and PHREEQC
BGR	OpenGeoSys coupling with PHREEQC, ChemApp, GEMIPM2K
CAS	Elasto-Plastic Cellular Automaton (EPCA) and TOUGH2

Task B2	
LBNL/DOE	TOUGH-FLAC and ROCMASS (complementary software for confidence building)
KAERI	TOUGH2-FLAC3D
Summary of Discussion	1. Limited data are available for comparison (heating started in January 2015, with data available through March 2015). 2. Models are mostly 3D or 2D axisymmetric, and most models are quite consistent with each other for temperature, and to a lesser extent for pressure, stress, displacement, and saturation. 3. Modeled heater temperatures were substantially larger than observed for the first two months. 4. Only KAERI modeled the buffer as elastoplastic; the others modeled it as elastic, with substantially different displacements.
Future Work	1. Complete the final report and papers.
Action Items for NRC/CNWRA staff	None. NRC is not a participant in this task.

Task C1	
Brief Description of the Overall Task	Investigate and mathematically model coupled THMC processes using data from laboratory experiments on single fractures through a novaculite (dense microcrystalline quartz rock) and a granitic rock. The experiments are described in Yasuhara et al. (2006, 2011).
Brief Description of the Current Steps	Step 0—Basic benchmarking for novaculite: • Use profilometer data as a representation of the topology of fracture surfaces to guide grid generation or estimation of statistical parameters of aperture distribution. • Use the aperture distribution data from Yasuhara et al. (2006) to reproduce the observed flow rate at the start of the experiment only (stop at 1,292 hours, before flow reversal). • Geochemistry Benchmark Test: Represent stylized batch experiment of silicate (Si) dissolution in deionized water under no-low conditions in a 10-μm aperture fracture and no mechanical coupling at temperatures of 20, 60, and 120 °C. Step 1—Continue modeling of Yasuhara et al. (2006) experiment: • Include the flow reversal, stop at ~1,500 hours. Step 2—Continue to end of Yasuhara et al. (2006) experiment: • Includes nonisothermal portion of experiment. Step 3—Yasuhara et al. (2011) granite experiment: develop geochemical model for granite Step 4—Simulate isothermal part of Yasuhara et al. (2011) granite experiment

Task C1	
	Step 5—Simulate nonisothermal part of Yasuhara et al. (2011) granite experiment Step 6—Reporting phase
Participant/Funding Organization	Software Used
RWM/Quintessa/ICL/UoE	QPAC and OpenGeoSys
UFZ/BGR	OpenGeoSys
CAS	Elasto-Plastic Cellular Automaton (EPCA) and TOUGHREACT
NRC	(1) Compartmental approach, modified from that in Yasuhara papers (2) HBGC123D+Aperture Module (stress incorporated only in the Aperture Module) (3) Geochemical Workbench
RAWRA/TUL	Geochemist’s Workbench, Semchem software, Transport, Flow123D, FEFLOW
Summary of Discussion	Most of the teams completed modeling Steps 1 and 2. The teams, in general, were able to match the evolution of hydraulic aperture and Si concentration observed in the experiment. Observations made based on the analysis of the numerical modeling results include: (i) there is uncertainty about what is causing the shutdown in the mechanical evolution (experimental artefact or a real process) required for models with good fits at the end of Step 1; (ii) enhanced free face dissolution could be limited at later time by channelization, reduction in dissolution area because of enhanced diffusion, or smoothing of surfaces. For Step 3, ICL and UoE teams extended the use of a statistical approach discussed by several teams in Steps 1 and 2 to analyze results from the granite experiment. A comparison of evolution of the Si concentration indicated a large variation in rates at 25 °C and a closer trend at 90 °C. The approach to implement Si dissolution (rate equations) differed among teams. For Steps 4 and 5, the teams, in general, were able to represent the aperture closure. The geochemical results were very different. Characterization of uncertainty and process model insights has been very useful. It was very difficult to construct blind predictive models because of large and model-specific rate enhancement processes. In a more general sense, conclusions from the novaculite and granite modeling indicate that competing THMC processes make it difficult to predict aperture closing and permeability changes. Pressure dissolution, stress corrosion cracking, thermal expansion, damage, creep, and matrix diffusion may all play different relative roles depending on the conditions and materials of a particular system.
Future Work	1. The final Task C1 report was submitted to the Secretariat at the end of November 2015, and pending the Secretariat’s review, the report will be published by December 31, 2015.

Task C1	
	2. Provide input to the journal articles. Draft versions to be ready by end of November 2015.
Action Items for NRC staff	Staff contributions for Task C1 in 2014 and 2015 were limited by Yucca Mountain responsibilities. NRC staff contributed to task report and novaculite journal paper prior and immediately after the 8th workshop. The journal paper is pending reviews from other team members.

References:

Yasuhara, H., A. Polak, Y. Mitani, A. Grader, P. Halleck, and D. Elsworth. "Evolution of Fracture Permeability Through Fluid–Rock Reaction Under Hydrothermal Conditions. *Earth and Planetary Science*. Letters 244. pp. 186–200. 2006.

Yasuhara, H. and D. Elsworth. "Compaction of a Rock Fracture Moderated by Competing Roles of Stress Corrosion and Pressure Solution. *Pure and Applied Geophysics*. Vol 165. pp. 1,289–1,306. 2008.

Yasuhara, H., N. Kinoshita, H. Ohfuji, D.S. Lee, S. Nakashima, and K. Kishida. "Temporal Alteration of Fracture Permeability in Granite Under Hydrothermal Conditions and Its Interpretation by Coupled Chemo-Mechanical Model. *Applied Geochemistry*. Vol. 26. pp. 2,074–2,088. 2011.

Task C2	
Brief Description of the Overall Task	Regional flow and transport in saturated fracture network above the Bedrichov tunnel, Czech Republic, using measured data for conservative and nonconservative tracers. Constraints on flow and transport to be enhanced by utilization of natural tracers for water age from natural tracers and rock mineral dissolution to incorporate water chemical compositions.
Brief Description of the Current Task	Update steady-state hydraulics and pulse tracer and perform introductory transient hydraulics. The task involves development of the numerical models using a 2D/3D segment of the tunnel 1. Hydrological processes: (i) fit the water inflow (hydraulics), (ii) fit the lumped parameter models of tracers, and (iii) fit a batch reaction experiment (crushed granite leaching). 2. Coupled processes/cross-validation: (i) develop 1D reactive transport using field chemical data, (ii) fit the isotope tracers with 2D/3D numerical transport (including hydraulics), and (iii) compare 2D/3D numerical advection with lumped parameter (fictitious tracer). 3. Refined modeling tasks: (i) refine the water inflow conceptual model and data, (ii) calculate 2D/3D transport with simplified chemistry, (iii) combine/calibrate all together, (iv) consider transient hydraulics and (v) inverse method (data fitting by optimization methods) and uncertainty analyses.
Participant/Funding Organization	Software Used
TUL/RAWRA	Flow123D
SNL/DOE	PFloTran and DAKOTA
BGR	RockFlow, OGS

Summary of Discussion	The teams analyzed water inflow rates into the Bedrichov tunnel and natural tracer data for two shallow (M1 and M2) and two deep (M3 and M4) modeling cases. The teams compared models using similar inputs for simpler basic problems, showing that the models compared reasonably well with each other. For more complex problems, there was less consistency between the models. The hydraulic models may have needed an unsaturated component for proper fitting. The natural tracer tests were able to be constrained with the shallow models, with some issues regarding uniqueness, but the tracers were difficult to work with for the deeper models because the time scale for variations was too long for seasonal fluctuations but too short for climatic changes. The scale of the problem led to issues with model dimensionality and heterogeneity, as well as issues with appropriately defining mean residence time.
Future Work	1. Complete the final team report and journal articles.
Action Items for NRC/CNWRA staff	None. NRC is not a participant in this task.

<u>Planning for DECOVALEX–2019</u>

With DECOVALEX-2015 ending at the end of this calendar year, potential tasks were presented for the next phase, DECOVALEX-2019. These include five primary tasks and two supplementary tasks. The primary tasks had four or more funding organizations expressing interest:

- Gas migration in bentonite, especially rates of advection versus diffusion
  - — Develop modeling approaches to understand the multiscale measurements, observations, and significance of advective gas migration in bentonite buffer and clay host rocks
  - — Sponsored by British waste management organization, RWM, and British Geological Survey
- Fault Slip (FS) experiment at Mont Terri, Switzerland
  - — Develop better understanding of conditions for slip activation and stability of faults for the purposes of understanding both fluid migration and risk of induced seismicity; includes two field experiments underway in Switzerland and France
  - — Sponsored by the Swiss regulator, ENSI
- Aveoloe (HA) and NSC experiments at Bure URL, France
  - — Modeling thermal-mechanical processes in full-scale disposal cell emplacement with a steel liner but no bentonite in argillite rock
  - — Modeling *in situ* hydromechanical processes of a bentonite/cement plug
  - — Sponsored by the French waste management organization, ANDRA
- Thermal-hydrological-mechanical interactions in argillaceous rocks and bentonite buffer
  - — Model (at least) ten years of natural and artificial resaturation of bentonite based on observations at two different tests: (i) the upcoming dismantling of the FEBEX field test at Grimsel, Switzerland, hosted in granitic rocks, and (ii) the already-dismantled EB test in the Mont Terri argillite host rock
  - — Sponsored by the Spanish waste management organization, ENRESA
- Groundwater Recovery experiment (GREET) in Mizunami URL
  - — Simulation of a field experiment designed to facilitate understanding of the response of the natural system surrounding a repository after permanent closure
  - — Sponsored by the Japanese waste management organization, JAEA

Two supplementary tasks will have a less prominent role in workshops because of interest from fewer potential funding organizations:

- Estimation of rock mass conductivity evolution in the near-field of a spent fuel repository
  - — Reliability, feasibility, and significance of estimation techniques for equivalent hydraulic conductivity (i) through and around boreholes, (ii) through damage zones surrounding excavations in granitic rock, and (iii) along waste package/buffer interfaces
  - — Sponsored by Swedish regulator, SSM
- Fluid inclusion migration
  - — Modeling fluid movement in argillaceous and salt rocks related to fluid inclusions, in both ambient and thermal environments
  - — Sponsored by German waste management supporting organization, BGR.

Most of the current participating organizations plan to join the DECOVALEX-2019 project, including the U.S. DOE. The Chinese Academy of Science has indicated that it may drop out. Likely new participants include ANDRA and ENRESA, which are the French and Spanish implementer organizations. The Swedish regulator, SSM, has proposed a potential task for DECOVALEX-2019, and thus also appears likely to join DECOVALEX-2019.

The NRC remains off the list of tentative participants in DECOVALEX-2019 based on the agency priorities being discussed as part of the re-baselining activities currently underway. Commitments for participation in DECOVALEX-2019 will be needed by the end of January 2016, so that the international agreement can be distributed and signed before the first workshop in May 2016.

Technical Site Visit

Staff from JAEA led a half-day technical visit to the Horonobe Underground Research Laboratory (URL) on the second day of the workshop. The groundwater in the argillaceous rocks at Horonobe URL has an elevated salinity. (The other underground research laboratory in Japan, the Mizunami URL, has low salinity water in a fractured granitic host rock.) The visit included presentations at the surface facilities and a walking tour around a loop of the 350-m gallery (i.e., at a depth of 350 m). At the surface facility, repository concepts and demonstration projects were included as part of the guided tour. A particularly interesting hands-on display involved uncapped bottles of water turned upside down into bentonite, and then immediately being lifted, held upside down, spun around several times, and set upright on the table without spilling any water. The bentonite expanded upon contact with water and sealed the bottles. The bottles remained sealed even after several repetitions of a large nail penetrating and being withdrawn from the bentonite.

The primary focus was the ongoing heater experiment with bentonite buffer, which is the *in situ* experiment being modeled for Task B2 of DECOVALEX-2015. Other experiments along the 350-m gallery included sorption and tracer tests, as well as numerous geological and geotechnical measurements being made to help understand the deep geological environment. Flow rates in some horizons at Horonobe URL are much greater than those in the argillites of the European URLs, such as Mont Terri, Bure, or Tournemire.

WORKSHOP AGENDA

DECOVALEX-2015 8th Workshop & Steering Committee Meeting
13th–15th October 2015, Wakkanai, Japan

Tuesday 13 Oct

8:30-9:00		Registration	
		Workshop Opening by Yutaka Sugita (JAEA, Japan)	
9:00-9:10		Introduction to the Workshop (John A. Hudson)	
9:10-12:00		**Task A** (Chaired by Alain Millard, CEA, France)	
	9:10-9:20	Problem definition, team structure, achievements and issues to be discussed for Task A – a brief summary (Alain Millard, CEA, France)	
	9:20-9:40	Research performed and achievements for Task A (Nadia Mokni, IRSN, France)	
	9:40-10:00	Research performed and achievements for Task A (Thanh Son Nguyen, CNSC, Canada)	
	10:00-10:20	Research performed and achievements for Task A (Andrew Fraser-Harris, Univ. of Edinburgh/RWM, UK)	
	10:20-10:50	Coffee/tea break	
	10:50-11:10	Research performed and achievements for Task A (Renchao Lu/ Hua Shao, BGR, Germany)	
	11:10-11:30	Research performed and achievements for Task A (Radim Blaheta, UGN/RAWRA, Czech)	ANA hotel
	11:30-12:00	Discussions (with focus on achievements, outstanding issues, final report and journal publications) (Led by Alain Millard, CEA, France)	
12:00-13:00		Lunch	
13:00-16:50		**Task B1** (Chaired by Herwig Müller, NAGRA Switzerland)	
	13:00-13:10	Problem definition, team structure, achievements and issues to be discussed for Task B1 – a brief summary (Herwig Müller, NAGRA, Switzerland)	
	13:10-13:30	Research performed and achievements for Task B1 (Hua Shao, BGR/UFZ , Germany)	
	13:30-13:50	Research performed and achievements for Task B1 (Pengzhi Pan, CAS, China)	
	13:50-14:10	Research performed and achievements for Task B1 (Jonny Rutqvist, LBNL/DOE, USA)	
	14:10-14:30	Research performed and achievements for Task B1 (Bastian Graupner, Johannes, ENSI, Switzerland)	

	14:30-14:50	Research performed and achievements for Task B1 (Thanh Son Nguyen, CNSC/IRSN, Canada/France)	
	14:50-15:20	Coffee/tea break	
	15:20-15:40	Research performed and achievements for Task B1 (Yusuke Takayama, JAEA, Japan)	
	15:40-16:00	Research performed and achievements for Task B1 (Heui Joo/Geon Young Kim, KAERI, Republic of Korea)	
	16:00-16:20	Research performed and achievements for Task B1 (Stuart Stothoff, CNWRA/NRC, USA)	
	16:20-16:50	Discussions (with focus on achievements, outstanding issues, final report and journal publications) (led by Herwig Müller, NAGRA, Switzerland)	
	16:50-17:05	D-2019 Website Arrangement (led by Jens Birkholzer)	

Wednesday 14 Oct

7:00		Departure	Chartered bus
8:10-8:40		Current status of Japanese Programme (Tomoo Fujita (JAEA))	
8:40-11:30		**Task B2** (Chaired by Yutaka Sugita (JAEA))	
	8:40-8:50	Problem definition, team structure, achievements and issues to be discussed for Task B2— a brief summary (Yutaka Sugita, JAEA, Japan)	
	8:50-9:10	Research performed and achievements for Task B2 (Hua Shao, BGR, Germany)	International Communication House, JAEA Horonobe
	9:10-9:30	Research performed and achievements for Task B2 (Pengzhi Pan, CAS, China)	
	9:30-10:00	Coffee/tea break	
	10:00-10:20	Research performed and achievements for Task B2 (Jonny Rutqvist, LBNL/DOE, USA)	
	10:20-10:40	Research performed and achievements for Task B2 (Yutaka Sugita, JAEA, Japan)	
	10:40-11:00	Research performed and achievements for Task B2 (Sangki Kwon, Inha Univ., Republic of Korea)	
	11:00-11:30	Discussions (with focus on achievements, outstanding issues, final report and journal publications) (Led by Yutaka, Sugita, JAEA, Japan)	
11:30-12:30		Lunch	
13:00-16:00		Horonobe URL	Horonobe URL
16:00-		Departure	Chartered bus
17:00		Back to the hotel	
17:30-19:30		Dinner	ANA Hotel

Thursday 15 Oct

8:00-11:30		**Task C1** (Chaired by Alex Bond, Quintessa, UK)	
	8:00-8:10	Problem definition, team structure, achievements and issues to be discussed for Task C1 – a brief summary (Alex Bond, Quintessa/RWM, UK)	
	8:10-8:30	Research performed and achievements for Task C1 (Pengzhi Pan, CAS, China)	
	8:30-8:50	Research performed and achievements for Task C1 (Philipp Lang, ICL/RWM, UK)	
	8:50-9:10	Research performed and achievements for Task C1 (Jan Sembara, TUL/RAWRA, Czech))	
	9:10-9:30	Research performed and achievements for Task C1 (Alex Bond, Quintessa/RWM, UK)	
	9:30-9:50	Research performed and achievements for Task C1 (Yifeng Wang, SNL/DOE, USA)	
	9:50-10:20	Coffee/tea break	
	10:20-10:40	Research performed and achievements for Task C1 (Renchao Lu/Hua Shao, BGR, Germany)	
	10:40-11:00	Overview of research and achievements for the whole of Task C1 (Alex Bond, Quintessa/RWM, UK)	ANA hotel
	11:00-11:30	Discussions (with focus on achievements, outstanding issues, final report and journal publications) (Led by Alex Bond, Quintessa/RWM, UK)	
11:30-12:30		Lunch	
12:30-14:10		**Task C2** (Chaired by Milan Hokr, TUL, Czech)	
	12:30-12:40	Problem definition, team structure, achievements and issues to be discussed for Task C2— a brief summary (Milan Hokr, TUL, Czech)	
	12:40-13:00	Research performed and achievements for Task C2 (Yifeng Wang, SNL/DOE, USA)	
	13:00-13:20	Research performed and achievements for Task C2 (Milan Hokr, TUL/RAWRA, Czech)	
	13:20-13:40	Research performed and achievements for Task C2 (Hua Shao, BGR, Germany)	
	13:40-14:10	Discussions (with focus on achievements, outstanding issues, final report and journal publications) (Led by Milan Hokr, TUL, Czech)	
14:10-14:30		Coffee/tea break	
14:30-16:00	90 minutes	Steering Committee Meeting DECOVALEX-2015 Agenda to be circulated to D2015 FOs	

		(Chaired by John A. Hudson, IC, UK)
16:00- 19:00+	180 minutes+	Steering Committee Meeting DECOVALEX-2019 (9:00–12:00+ in Europe) Agenda to be circulated by Jens to those taking part (Chaired by Jens Birkholzer, LBNL, USA)

END OF WORKSHOP