

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: GeoProc International Conference on Coupled Thermal-Hydrological-Mechanical-Chemical Processes in Geosystems (20.06002.01.101)

DATE/PLACE: October 13–17, 2003, Stockholm, Sweden

AUTHOR: Ronald T. Green

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PERSONS PRESENT:

There were 134 registered participants representing 20 countries, including Mysore Nataraja of NRC. The attendance list is attached.

BACKGROUND AND PURPOSE OF TRIP

The purpose of this trip was to attend the GeoProc Conference and present the final results of the analyses conducted at CNWRA for the DECOVALEX III project.

SUMMARY OF PERTINENT POINTS:

There were 134 participants at the GeoProc Conference representing 20 countries. A total of 102 papers were to be presented, but there were a few cancellations. There were 8 keynote presentations during plenary sessions. All remaining papers were presented during two concurrent sessions over the course of three days. The conference was followed by a Task 2 (drift-scale heater test) task force meeting and a DECOVALEX steering committee meeting. The schedule to complete preparation of the final Task 2 DECOVALEX III documents was identified during the task force meeting. Similar discussions were held during the DECOVALEX III steering committee meeting. In addition, the steering committee discussed the potential guidelines for a continuation of the international coupled processes benchmark modeling projects, of which DECOVALEX III is the most recent. The tentative consensus of most team members was to continue the modeling comparison as a new project.

There was a total of 15 themes presented as conference sessions. Eight sessions were associated with the DECOVALEX III project or with similarly related high-level waste studies. Other session themes addressed fundamentals of material characterization and modeling tools, processes for oil/gas reservoir engineering, and geothermal energy engineering, all in terms of coupled geoprocesses.

After Ove Stephansson made a welcoming speech and Chin-Fu Tsang provided an overview of the DECOVALEX III project, Ivars Neretnicks/KTH provided comprehensive opening remarks of coupled processes active in fractured rock. Neretnicks identified the prediction of solute transport through fractured rock as the primary objective for geoprocesses issues. He identified the residence time distribution (RTD) as an appropriate measure of solute transport through

fractured rock. The current conceptual model is predicated on the presumption that flow is limited to isolated pathways. Neretnicks identified the two most prominent classes of flow wetted surface (FWS) conceptual models as network models and streamline models. Sub-issues germane to these models are matrix diffusion (i.e., pore surface area), fracture characterization, and transverse solute spreading (i.e., does fracture flow mix or split).

Robin Datta/BSC opened the session on the drift-scale heater test analyses with an overview of the drift-scale heater test design, operation, and results. The presentation by Datta also included limited results of the pre-test modeling analyses performed by LBNL. There were five topical papers on the drift-scale heater test: "Analysis of stress and moisture induced changes in fractured rock permeability" by Rutquist, Tsang, and Tsang; "Thermal-mechanical modeling of a large-scale heater test" by Hsiung, Chowdhury, and Nataraja; "Numerical simulation of thermohydrological processes observed at the drift-scale heater test" by Green and Painter; "THM analysis of a heating test in a fractured tuff" by Olivella, Gens, and Gonzalez; and "Comparative analyses of predicted and measured displacements during the heating phase of the Yucca Mountain Drift Scale Test" by Millard, and Rutquist. Jonny Rutquist/LBNL presented his thermal-hydrological-mechanical results as part of the SKI team. Sebastia Olivella/UPC presented the thermal-hydrological-mechanical results for ENRESA. Ron Green/CNWRA presented the thermal-mechanical results of Simon Hsu for NRC. Alain Millard/CEA presented the CEA thermal-hydrological-mechanical results of his collaboration with Rutquist. The results documented in these papers summarized the results of the various teams at the conclusion of DECOVALEX III project.

There are two fully coupled thermal-hydrological-mechanical codes that have been used in the DECOVALEX III project. The TOUGH2-FLAC code was developed by Jonny Rutquist/LBNL and CODE_BRIGHT was developed by Sebastia Olivella/UPC. Rutquist used FISH to develop the routine to couple the commercial rock mechanics code FLAC to the LBNL thermal-hydrological research code TOUGH2. CODE_BRIGHT is a fully coupled thermal-hydrological-mechanical code. Both used their codes to analyze the drift-scale heater test at Yucca Mountain. In addition, Alain Millard/CEA teamed with Rutquist and used TOUGH2-FLAC to perform a series of parametric analyses of the rock response at the drift-scale heater test. Rutquist also has used his own code, ROCKMAS, to perform coupled thermal-mechanical analyses as part of the FEBEX modeling exercise.

Olivella has continued to enhance the capabilities of his thermal-hydrological-mechanical code CODE-BRIGHT. He has recently incorporated the capability of a double structure medium into his code. The double structure is similar to the dual continua and dual permeability capability of MULTIFLO and TOUGH2, respectively.

Temperature predictions of the drift-scale heater test by Green and Painter were close to those observed during the four-year long heating phase, with the exception of temperatures observed proximal to the heated drift wall. A 30-percent reduction in the canister heat load reduced, but did not fully eliminate, the difference between the simulated and observed temperatures. A 30-percent reduction in canister heat roughly equates to the amount of measured conductive and radiative heat lost through the thermal bulkhead. In comparison, temperature simulated near the drift wall by the LBNL team, are very close to those observed during the heating phase. Discussions with Rutquist clarified that the LBNL drift-scale heater test models assigned the observed temperatures as the drift wall boundary conditions. This procedure clarifies why the LBNL drift-scale heater test models successfully match the observed drift wall temperatures.

Conversely, specifying the temperature at the drift wall limits the ability of model results to explain heat and mass loss through the thermal bulkhead and raises the question whether their thermohydrological models actually capture all important processes active during the heating phase of the drift-scale heater test.

The GeoProc steering committee decided to provide non-copyrighted (i.e., no ISBN number) hard copy and CD versions of the conference proceedings at the time of the conference. This decision caused some consternation by conference attendees because the conference results cannot be cited in the absence of the ISBN number. This limitation is to be alleviated when the proceedings are published in a book. John Hudson is a member of the GeoProc steering committee and the editor of the International Journal of Rock Mechanics (IJRM). Hudson and the steering committee are sufficiently impressed with the caliber of the GeoProc papers that two IJRM journals are to be dedicated to publish expanded versions of the GeoProc papers. One journal will be dedicated to the DECOVALEX III related papers and the other to the non-DEVOCALEX III related papers.

The DECOVALEX III steering committee met to discuss issues related to the conclusion of DECOVALEX III and the formation of a new international modeling project whose objective is to compare the development, implementation, and results of coupled thermal-hydrological-mechanical-chemical models used to predict the geologic performance of high-level waste geologic repositories. Preliminary discussions recognized the need to include chemical couplings in the mandate of the proposed modeling project. The name would be DECOVALEX-THMC to reflect the added importance of the fully coupled system to repository performance assessment.

Participants to DECOVALEX III were asked whether their respective organizations are interested in continuing their involvement in DECOVALEX-THMC. Eight organizations indicated the affirmative: ENRESA (Spain), JNC (Japan), CNSC (Canada), AECL (Canada), DOE (USA), BGR (Germany), SKI (Sweden), SKB (Sweden). Two organizations indicated their involvement was not clear at this time: NRC (USA) and CEA (France). Stuk (Finland) and NIREX (England) said that their organizations would not be participants. The English high-level waste disposal program is currently on hold. A panel is being convened in England with the mandate to evaluate the feasibility of all possible programs (i.e., from deep sea disposal to a space launch program) prior to selection of a high-level waste disposal plan. The panel is to report its findings by the end of 2004. Chin-Fu Tsang reported that three additional organizations have expressed a desire to participate in DECOVALEX-THMC: ETH-Lausanne (Switzerland), ETH-Zurich (Switzerland), and TON (Netherlands).

Chin-Fu Tsang, John Hudson, and Ove Stephansson are to collate all project recommendations and send a draft to the interested parties by the end of November 2003. Comments are to be incorporated and the final document will be sent out by the end of 2003. An organizational meeting is tentatively scheduled for early March in Paris. The cooling phase of the drift-scale heater test was discussed as one of the possible test cases.

SUMMARY OF ACTIVITIES:

Ronald Green presented results from thermal-hydrological analyses by Green and Painter and thermal-mechanical analyses by Hsuing, Chowdhury, and Nataraja of the drift-scale heater test. Green and Nataraja attended a task force meeting on Task 2 and the Steering Committee meeting for DECOVALEX III.

CONCLUSIONS:

The quality of papers and presentations at the conference was very impressive. Almost all keynote presentations were well prepared and given by leaders in their respective fields. The DECOVALEX III project talks were all well done, mostly due to the fact that the papers summarize the conclusions of four years of research. The conference was also exceptional because the technical scope of all themes focused on coupled processes in geosystems. Virtually all presentations, with the exception of a few that were aimed at oil/gas or geothermal applications, were germane to issues facing geologic disposal of high-level waste.

PROBLEMS ENCOUNTERED:

None

PENDING ACTIONS:

NRC and CNWRA need to decide whether to continue participation in DECOVALEX-THMC.

RECOMMENDATIONS:

DECOVALEX III offered the unique opportunity to interact with the international technical community to compare sophisticated modeling approaches, conceptual models, applications, and results as applied to coupled processes associated with high-level waste geologic disposal. This opportunity is not offered elsewhere. Most countries that are actively evaluating long term geologic disposal of high-level waste are actively involved in this international benchmark modeling effort. NRC/CNWRA should consider participation in DECOVALEX-THMC as a part of performance confirmation program.

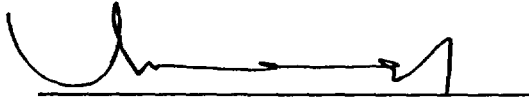
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Ronald T. Green
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10/28/03
Date

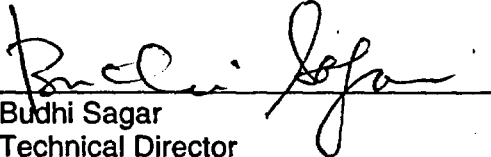
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GeoProc²⁰⁰³

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