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SUBJECT: DECOVALEX WORKSHOP-TRIP REPORT

I attended an international workshop on coupled thermal-hydrological-mechanical (THM) processes for waste repositories held in Sweden between March 23 and 25, 1999, and also visited the underground test facility at Äspö on March 26, 1999. This trip report summarizes the highlights of the meeting and the site visit.

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BACKGROUND

DECOVALEX is the acronym for **DEVELOPMENT OF COUPLED MODELS AND THEIR VALIDATION AGAINST EXPERIMENTS.** DECOVALEX is an international cooperative project that supports the development of mathematical models of coupled THM processes in the geosphere and their applications and validation against experiments in the field of nuclear waste isolation. The steering committee for the project is managed by the Swedish Nuclear Power Inspectorate (SKI) through the Swedish Royal Institute of Technology and is chaired by Dr. Chin Fu Tsang of the Lawrence Berkeley National Laboratory. More than a dozen countries participate both by funding and by actual performance of tasks. Phase I and phase II of the project have been completed and Nuclear Regulatory Commission (NRC) participated in the first phase between 1992 to 1995. After a lapse of four years (phase II, 1995-1999), NRC has decided to support phase III. The workshop I attended was to review the progress to date and plans for the future.

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DECOVALEX PHASE I

During phase-I of the project, three benchmark tests were studied: (1) BMT1- Far-field model to simulate THM processes in a large volume of rock located at 500 meters depth; (2) BMT2 - Near-field model of a multiple-fractured rock mass; and (3) BMT3 - Near field model of a

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realistic fracture network around a rock opening 50mX50m, 500m deep. Six test case problems were also studied: (1) TC1 - Study of a coupled shear flow experiment of a single rock joint (Norway); (2) TC2 - In situ Thermal-Mechanical (TM) experiment at Fanay Augeres (France); (3) TC3 - Laboratory experiment of engineered barriers (Japan); (4) TC4 - Hydrological-Mechanical (HM) behavior of rock joints (Finland); (5) TC5 - HM behavior of jointed rocks (USA); and (6) In situ borehole injection, HM study (Sweden). After the study of benchmark tests and the test cases, it was concluded that: (1) the thermal processes in fractured and continuous media were well understood and that the existing models could be successfully used to predict temperature distributions; (2) mechanical processes such as distribution of stresses around excavations were reasonably predicted using the current models while the reliability of displacement predictions would depend on the extent of fractures and their distribution; and finally, (3) hydrologic processes in fractured rocks were not well understood.

DECOVALEX PHASE II

During phase II of the project, two field studies were modeled: (1) Kamaishi mine engineered barrier study in Japan; and (2) Sellafield intermediate waste repository in UK. In addition, two studies were undertaken, one on the review of constitutive models for jointed rocks and the other on the review of THM processes that might have an impact on performance assessments. Because the Sellafield shaft construction was canceled, many of the "blind" predictions made by participating organizations using different conceptual models and numerical codes could not be verified. The results of the Kamaishi experiment showed different degrees of agreement with actual measured/observed behavior. The lessons learned during phase II are summarized in the following main conclusions: (1) a THM predictive capability is required to support repository design because there is no past experience in this area; (2) many aspects of THM processes and modeling are now well understood and there is a variety of numerical codes available to provide solutions for different host rock and repository conditions; (3) modeling all the THM mechanisms in space and time is extremely complex and therefore, simplifications will have to be made; (4) it is not always possible to obtain all the necessary detailed supporting information for use in the modeling studies; (5) the THM modeling requirements and the supporting data needs should be defined in the context of performance assessment; and finally, (6) a transparent audit trail should be developed to help documentation of all testing, modeling and analyses.

DECOVALEX PHASE III

The objectives of DECOVALEX phase III are the same as those for the previous two phases, namely: (1) to increase the basic understanding of THM coupled processes in fractured rocks and buffer materials; (2) to investigate the predictive capabilities of different codes by comparison of results with field test data; (3) to exchange experimental data and improve understanding of constitutive laws for rock masses and buffer materials; and (4) to review the state of the art in coupled THM issues in performance assessment. The steering committee has agreed to conduct four tasks under phase III and they are: (1) modeling of a field test conducted in Switzerland; (2) modeling of Yucca Mountain drift scale heater test; (3) modeling of selected benchmark test problems for treatment of coupled THM processes in performance assessment; and (4) establishing a forum to discuss and document methodologies for the treatment of THM processes in performance assessment. NRC has committed to participate in Task-2, modeling of the drift scale heater test at the Yucca Mountain site.

SITE VISIT TO THE ÄSPÖ HARD ROCK LABORATORY

The Swedish Nuclear Fuel and Waste Management Company (SKB) has constructed an exploratory test facility known as the ÄSPÖ Hard Rock Laboratory (HRL) in order to provide an opportunity for research development and waste emplacement and retrieval demonstration in a realistic and undisturbed underground rock environment at the future repository depth. The geotechnical investigation to select the HRL site began in 1986 and the construction of the facility started in 1990 and ended in 1995. More than ten years of research data have been collected at various depths, maximum depth being 460 meters below the surface. Tests to characterize flow through fractures, backfill saturation, and mechanical-hydrological coupled behavior are currently in progress. Many of the numerical codes considered by the participants of DECOVALEX project are being used by SKB investigators successfully to make predictions for validation.

NEXT STEP

The steering committee has finalized its proposal for phase III activities after discussions during the meeting at Kalmar, Sweden. The next step for NRC is to sign the contract agreement with SKI and take steps to transfer funds for the fiscal year 1999. The agreed date for starting work is July 1, 1999. There will be a meeting in Las Vegas during the fall of 1999 when the participating organizations will meet to receive the necessary data for task 2 (modeling of the Yucca Mountain drift scale heater test). Repository Design Thermal Mechanical Key Technical Issue will appropriate necessary funds at the Center for Nuclear Waste Regulatory Analyses for conducting modeling studies during the next fiscal year (FY 2000).

If there are any questions about my trip or the contents summarized in this trip report, I can be contacted at (301) 415-6695 or though e-mail (msn1).

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