

**TOUGH**  
symposium  
2006



# **TOUGH Symposium 2006**

**Lawrence Berkeley National Laboratory**

**Building 50 Auditorium**

**Berkeley, California**

**May 15–17, 2006**

**Technical Program**

**Rev. 9.0**

# **TOUGH Symposium 2006**

**Lawrence Berkeley National Laboratory  
Berkeley, California  
Building 50 Auditorium  
May 15–17, 2006**

## **Agenda Outline**

### **Monday, May 15, 2006**

7:30 am Registration  
8:30 am Oral Session: Environmental Engineering  
10:15 am Coffee Break  
10:45 am Oral Session: Environmental Engineering (cont.)  
12:00 noon Lunch  
1:30 pm Oral Session: Geothermal Reservoir Engineering  
3:10 pm Coffee Break  
3:40 pm Oral Session: Geotechnical Engineering  
5:30 pm Poster Session and Reception, LBNL Cafeteria

### **Tuesday, May 16, 2006**

8:30 am Oral Session: Carbon Dioxide Storage  
9:45 am Coffee Break  
10:15 am Oral Session: Carbon Dioxide Storage (cont.)  
11:30 am Lunch  
1:00 pm Oral Session: Vadose Zone Hydrology  
2:40 pm Coffee Break  
3:10 pm Oral Session: Reactive Geochemistry  
6:30 pm Banquet, International House

### **Wednesday, May 17, 2006**

8:30 am Oral Session: Nuclear Waste  
10:10 am Coffee Break  
10:40 am Oral Session: Gas Hydrates  
11:30 am Lunch  
1:00 pm Tricks-of-the-Trade  
2:30 pm Coffee Break  
3:00 pm Panel Discussion  
4:30 pm Adjourn

<b>Monday, May 15, 2006, Morning Sessions</b>		
7:30	Registration, Building 50 Auditorium Foyer	
<b>Welcome and Opening Remarks</b>		
8:30 am	Welcome	Bo Bodvarsson, Director, Earth Sciences Division, LBNL
8:35 am	Opening Remarks	Karsten Pruess
8:45 am	Announcements	Organizing Committee
<b>Environmental Engineering</b>		
<i>Session Chair: Ronald Falta</i>		
9:00 am	Modeling Organic Spills in Coastal Sites with TMVOC V.2.0	Alfredo Battistelli (Snamprogetti SpA, Fano, Italy)
9:25 am	Multiphase Modeling and Inversion Methods for Controlling Landfill Bioreactor	Terhi Kling, Juhani Korkealaakso (Technical Research Centre of Finland, VTT, Finland)
9:50 am	Radionuclide Transport through a Low-Permeability Natural Gas Reservoir	Clay Cooper, Ming Ye, Jenny Chapman (Desert Research Institute)
10:15 am	<i>Coffee Break</i>	
10:45 am	Modeling Kinetic Interphase Mass Transfer During Field Scale Air Sparging Operations with a Dual Domain Approach	Darby VanAntwerp, Ron Falta (Clemson University, Clemson, SC)
11:10 am	Modeling NAPL Source Zone Formation in Stochastically Heterogeneous Layered Media - a Comparison with Experimental Results	Fritjof Fagerlund, Auli Niemi (Uppsala University, Sweden), Tissa Illangasekare (Colorado School of Mines, Golden, CO)
11:35 am	TOUGH+GasH2O Study of the Effects of a Heat Source Buried in the Martian Permafrost	George Moridis, Karsten Pruess (LBNL, Berkeley, CA)
12:00 noon	<i>Lunch, LBNL Cafeteria</i>	

## Monday, May 15, 2006, Afternoon Sessions

### Geothermal Reservoir Engineering

*Session Chair: Mario César Suárez Arriaga*

1:30 pm	Applying the Hengill Geothermal Reservoir Model in Power Plant Decision Making and Environmental Impact Studies	Grímur Björnsson, Einar Gunnlaugsson (Reykjavik Energy, Iceland), Arnar Hjartarson (Iceland Geosurvey, Iceland)
1:55 pm	Evaluation of C-14 as a Natural Tracer for Injected Fluids at the Aidlin Sector of the Geysers Geothermal System through Modeling of Mineral-Water-Gas Reactions	Patrick Dobson, Eric Sonnenthal, Jennifer Lewicki, Mack Kennedy (LBNL, Berkeley, CA)
2:20 pm	Shear Slip Analysis in Multi-Phase Fluid Flow Reservoir Engineering Applications Using TOUGH-FLAC	Jonny Rutqvist (LBNL, Berkeley, CA)
2:45 pm	Modeling of Gas Composition and Gravity Signals at the Phlegrean Fields Caldera	Micol Todesco, Giovanni Chiodini, Giovanna Berrino (Istituto Nazionale di Geofisica e Vulcanologia, Italy)
3:10 pm	<i>Coffee Break</i>	

### Geotechnical Engineering

*Session Chair: Julio Garcia*

3:40 pm	Flooding of an Abandoned Salt Mine – Modeling Two-Phase Flow in Complex Mine Structures	Joachim Poppei, Gerhard Mayer, Nicolas Hubschwerlen, Georg Resele (Colenco Power Engineering Ltd., Baden, Switzerland)
4:05 pm	ASCATA - A TOUGH2 Based Program for Automated Simulation of Compressed Air Tunnel Advance	Gerhard Steger, Stephan Semprich (TU Graz, Austria)
4:30 pm	Enhanced Seepage and its Effect on Slope Stability under Torrential Precipitate during Flood Discharge Event on a Large Hydroelectric Station	Mo Xu <sup>1</sup> , Guoping Lu <sup>2</sup> , Ying Ma <sup>1</sup> , Xiaobing Kank ( <sup>1</sup> Chengdu University, Chengdu, China; <sup>2</sup> LBNL, Berkeley, CA)
4:55 pm	The Lihir Open Pit Gold Mine Revisited	Stephen White, John Burnell (Industrial Research Ltd, Lower Hutt, New Zealand), Markos Melaku, Roy Johnstone (Lihir Management Company Ltd, Port Moresby, Papua New Guinea)

## Monday, May 15, 2006, Evening Poster Session and Reception

*Session Chair: Nicholas Halecky*

### Carbon Dioxide Storage and Gas Hydrates

P1	System-Level Modeling for Geological CO <sub>2</sub> Storage	Yingqi Zhang, Curt Oldenburg, Stefan Finsterle, Bo Bodvarsson (LBNL, Berkeley, CA)
P2	Sequestration of CO <sub>2</sub> in the Altmark Natural Gas Field, Germany: Mobility Control to Extend Enhanced Gas Recovery	Dorothee Rebscher <sup>1</sup> , F. May <sup>2</sup> , Curtis Oldenburg <sup>1</sup> ( <sup>1</sup> LBNL, Berkeley, CA; <sup>2</sup> Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Hannover, Germany)
P3	Comparison of Kinetic and Equilibrium Reaction Models in Simulating the Behavior of Gas Hydrates in Porous Media	Michael Kowalsky, George Moridis (LBNL, Berkeley, CA)
P4	Depressurization-Induced Gas Production from Class 1 and Class 2 Hydrate Deposits	George Moridis, Michael Kowalsky (LBNL, Berkeley, CA)
P5	Relative Permeability Estimates for Methane Hydrate-Bearing Sand	Yongkoo Seol, Timothy Kneafsey, Liviu Tomutsa, George Moridis (LBNL, Berkeley, CA)

### Computation Methods, Pre- and Post-Processing

P6	Efficient Scheme for Reducing Numerical Dispersion in Modeling Multiphase Chemical Transport in Porous and Fractured Media	Yu-Shu Wu (LBNL, Berkeley, CA), Peter Forsyth (University of Waterloo, Ontario, Canada)
P7	Enhancing Scalability and Efficiency of TOUGH_MP for Linux Clusters	Keni Zhang, Yu-Shu Wu (LBNL, Berkeley, CA)
P8	Using PetraSim to Create, Execute, and Post-Process TOUGH2 Models	Alison Alcott (RockWare Inc., Golden CO), Daniel Swenson, Brian Hardeman (Thunderhead Engineering, Manhattan, KS)
P9	Some Topological Aspects of (Un)Structured Generation of Meshes: A Possible Enhancement of Meshmaker in TOUGH	Juan Carlos Díaz Patiño, Ricardo Pacheco, Mario César Suárez Arriaga (Michoacán University, México)
P10	TOUGH+: The New Generation of Object-Oriented Family of Codes for the Solution of Problems of Flow and Transport in the Subsurface	George Moridis, Michael Kowalsky, Stefan Finsterle, Karsten Pruess (LBNL, Berkeley, CA)

P11	IGGI, A Computing Framework for Large Scale Parametric Simulations: Application to Uncertainty Analysis with TOUGHREACT	Fabrice Dupros, F. Boulahy, J. Vairon (BRGM, Orléans, France), P. Lombard (ICATIS, Meylan, France), N. Capit, J-F. Méhaut (Laboratoire ID-IMAG, Montbonnot Saint Martin, France)
P12	GeoCad2—A Pre- and Post-Processor for TOUGH2	Stephen White (IRL, New Zealand)
<b>Reactive Geochemistry and Environmental Engineering</b>		
P13	Simulation of Salt Water Intrusion	Kenzi Karasaki (LBNL, Berkeley, CA), Kazumasa Ito (AIST, Japan)
P14	The Relative Importance of Variable Water Infiltration Rate and Geological Heterogeneity for Three-Phase TCE Transport in a Porous Medium	Hanna Zandin, Auli Niemi (Uppsala University, Uppsala, Sweden)
P15	Implementation of the Pitzer Activity Model into TOUGHREACT for Modeling Concentrated Solutions	Guoxiang Zhang, Nic Spycher, Eric Sonnenthal, Carl Steefel (LBNL, Berkeley, CA)
P16	Modeling of the Laboratory Experiments Interaction of the Hot NaNO <sub>3</sub> -NaOH Brine with Sandstone Rocks from Deep Radionuclide Repository Site, Using TOUGHREACT	Alexey Kiryukhin (Institute of Volcanology and Seismology, Kamchatsky, Russia), E. P. Kaymin, E. V. Zakharova (Institute of Physical Chemistry, Moscow, Russia), A. A. Graphchikov (Institute of Mineralogy, Chernogolovka, Russia), A. A. Zubkov (Siberia Chemical Plant, Severesk, Russia)
P17	Simulation of the Effects of Hydrophilic Polymer Adsorption on Two-Phase Flow of Oil-Water Mixtures	Michele Carpita, Marica Marcolini, Alfredo Battistelli (Snamprogetti SpA, Fano, Italy)
<b>Geothermal Reservoir Engineering</b>		
P18	Modeling the Pauzhetsky Geothermal Field, Kamchatka, Russia, Using iTOUGH2	A. V. Kiryukhin <sup>1</sup> , N. P. Asaulova <sup>2</sup> , S. Finsterle <sup>3</sup> , T. V. Rychkova <sup>1</sup> , N. Obora <sup>2</sup> ( <sup>1</sup> Institute of Volcanology and Seismology, Kamchatsky, Russia; <sup>2</sup> Kamchatskburgeotemia Enterprize, Kamchatka, Russia; <sup>3</sup> LBNL, CA)
P19	TOUGH and the Boundary Element Method in the Estimation of the Natural State of Geothermal Submarine Systems	Mario César Suárez Arriaga (Michoacán University, México), Fernando Samaniego (National University of México, México)
P20	Modeling of Helium and Heat Transport in an Extensional Basin Using the Noble Gas Module EOSN in TOUGH2	Judy Andrews, Martin Saar (University of Minnesota—Twin Cities, Minneapolis, MN)

<b>Nuclear Waste</b>		
P21	Three Dimensional Analyses of Coupled Gas, Heat and Nuclide Transport in a Repository Including Rock Salt Convergence	Vijen Javeri (Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH, Köln, Germany)
P22	Design and Analysis of a Gas Threshold Pressure Test in a Low-Permeability Clay at ANDRA's Underground Research Laboratory, Bure (France)	Rainer Senger (INTERA Inc., Austin, TX), Cristian Enachescu (Golder Associates GmbH, Celle, Germany), Thomas Doe (Golder Associates Inc., Redmond, WA), Marc Distinguin, Jacques Delay (Andra, France)
P23	A Coupled Model for Natural Convection in Heated Subsurface Enclosures Embedded in Fractured Rock: TOUGH2 Enhancements and Simulation Examples	Nicholaus Halecky <sup>1,3</sup> , Jens Birkholzer <sup>1</sup> , Steve Webb <sup>2</sup> , P. F. Peterson <sup>3</sup> , Bo Bodvarsson <sup>1</sup> ( <sup>1</sup> LBNL, Berkeley, CA; <sup>2</sup> Sandia National Laboratories, Albuquerque, NM; <sup>3</sup> University of California, Berkeley, CA)
P24	Modifying TOUGH2 to Support Modeling of Gas Transport through Saturated Compacted Bentonite as Part of the Large-Scale Gas Injection Test (LASGIT) in Sweden	Nicola Calder, John Avis, Rainer Senger (INTERA Engineering Ltd., Ottawa, Canada), Helen Leung (Ontario Power Generation, Toronto, Canada)
<b>Vadose Zone and Fracture Hydrology</b>		
P25	Coupling TOUGH2 with CLM3: Developing a Coupled Land Surface and Subsurface Model	Lehua Pan, Jiming Jin, Norm Miller, Yu-Shu Wu, Bo Bodvarsson (LBNL, Berkeley, CA)
P26	Validation of the Active Fracture Model for Unsaturated Flow in Heterogeneous Fractured Rock Using Numerical Experiments	Quanlin Zhou (ETIC Engineering Inc., Oakland, CA)
P27	Numerical Simulation and Parameter Estimation Using Borehole Flowmeter Logging in Low Permeability Rocks	Kazumasa Ito, Naoto Takeno, Yoji Seki, Kazuki Naito, and Yoshio Watanabe (AIST, Japan)
P28	Modeling of Physical Observations of Water Diversion in a Capillary Barrier Using a Centrifuge	Hideo Nakajima (Research Center for Deep Geological Environments, Tsukuba, Japan), Julio Garcia (ETIC Engineering, Oakland Inc., CA), Robert Podgorney (INL, Idaho Falls, ID)

## Tuesday, May 16, 2006, Morning Sessions

### Carbon Dioxide Storage

*Session Chair: Stephen White*

8:30 am	ECO2N - A New TOUGH2 Fluid Property Module for Studies of CO <sub>2</sub> Storage in Saline Aquifers	Karsten Pruess, Nicolas Spycher (LBNL, Berkeley, CA)
8:55 am	Numerical Modeling of CO <sub>2</sub> Injection Test at Nagaoka Test Site in Nigata, Japan	Tatsuya Sato (GERD, Japan), Young Hong, Stephen White (IRL, New Zealand), Ziqiu Xue (RITE)
9:20 am	Joule-Thomson Cooling Due to Injection of CO <sub>2</sub> into Depleted Gas Reservoirs	Curtis Oldenburg (LBNL, Berkeley, CA)
9:45 am	<i>Coffee Break</i>	
10:15 am	Modeling Geologic Storage of Carbon Dioxide: Comparison of Non-Hysteretic and Hysteretic Characteristic Curves	Christine Doughty (LBNL, Berkeley, CA)
10:40 am	Modeling CO <sub>2</sub> Injection with Halite Precipitation Using an Extended Verma & Pruess Porosity-Permeability Model	Michele Carpita, Thomas Gioris, Alfredo Battistelli (Snamprogetti SpA, Italy)
11:05 am	A Long-Term 2D Vertical Modeling of the CO <sub>2</sub> Storage at Sleipner (North Sea) Using TOUGHREACT	Pascal Audigane, I. Gaus (BRGM, Orléans, France), Karsten Pruess, Tianfu Xu, (LBNL, Berkeley, CA)
11:30 am	<i>Lunch, LBNL Cafeteria</i>	

<b>Tuesday, May 16, 2006, Afternoon Sessions</b>		
<b>Vadose Zone Hydrology</b>		
<i>Session Chair: Lorraine Flint</i>		
1:00 pm	Investigation of Episodic Flow Events between Unsaturated Porous Media and Macropore Domains Using TOUGH2	Robert Podgorney (INL, Idaho Falls, ID), Jerry Fairley (University of Idaho, Moscow, ID)
1:25 pm	Investigating Nonlinear Rainfall-Runoff Response from a Trenched Hillslope Using TOUGH2 3-D Simulations	April James, Jeffrey McDonnell (Oregon State University, Corvallis, OR)
1:50 pm	Modeling Soil Moisture Processes and Recharge under a Melting Snowpack	Alan Flint, Lorraine Flint (USGS, Sacramento, CA)
2:15 pm	Joint Hydrological-Geophysical Inversion for Soil Structure Identification	Stefan Finsterle, Michael Kowalsky (LBNL, Berkeley, CA)
2:40 pm	<i>Coffee Break</i>	
<b>Reactive Geochemistry</b>		
<i>Session Chair: Nicolas Spycher</i>		
3:10 pm	Incorporation of Aqueous Reaction and Sorption Kinetics and Biodegradation into TOUGHREACT	Tianfu Xu (LBNL, Berkeley, CA)
3:35 pm	TOUGHREACT/ECO2 on Reactive Transport Modeling of CO <sub>2</sub> in a Geological Repository	Hakan Alkan, W. Müller, G. Bracke (Institute of Safety Technology, Germany)
4:00 pm	Solubility Enhanced Retardation of Neptunium in the Unsaturated Zone at Yucca Mountain, Nevada	Guoping Lu, Tianfu Xu (LBNL, Berkeley, CA)
4:25 pm	Uncertainty in the Reactive Transport Model Response to an Alkaline Perturbation in a Clay Formation	André Burnol <sup>1</sup> , P. Blanc <sup>1</sup> , Tianfu Xu <sup>2</sup> , Nicolas Spycher <sup>2</sup> , E. C. Gaucher <sup>1</sup> ( <sup>1</sup> BRGM, Orléans, France; <sup>2</sup> LBNL, Berkeley, CA)
6:30 pm	<i>Banquet, International House</i>	
7:30 pm	Why do Volcanoes (Only Sometimes) Erupt Explosively?	Michael Manga (University of California, Berkeley, CA)
8:30 pm	Bus leaving for Hotels Durant and Shattuck	

## Wednesday, May 17, 2006, Morning Sessions

### Nuclear Waste

*Session Chair: Bo Bodvarsson*

8:30 am	TOUGH2/iTOUGH2 Analysis of the Gas Migration Test (GMT) at the Grimsel Test Site (Switzerland)	Rainer Senger, (INTERA Inc., Austin, TX), Bill Lanyon Fracture Systems Ltd, Cornwall, UK), Paul Marschall, Stratis Vomvoris (NAGRA, Wettingen, Switzerland), Ai Fujiwara (RWMC, Tokyo, Japan)
8:55 am	Simulations of the Hydrogen Migration out of Intermediate Level Radioactive Waste Emplacement Drifts Using TOUGH2	Jean Talandier (Andra, Châtenay-Malabry, France), Gerhard Mayer, Jean Croisé (Colenco Power Engineering AG, Baden, Switzerland)
9:20 am	Three Dimensional Analyses of Combined Gas and Nuclide Transport in a Repository Considering Coupled Hydro-Geomechanical Processes	Vijen Javeri (Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH, Köln, Germany)
9:45 am	Joint Inversion of Ground-Penetrating Radar and Thermal-Hydrological Data Collected During a Large-Scale Heater Test	Michael Kowalsky, Jens Birkholzer, Stefan Finsterle, John Peterson, Sumit Mukhopadhyay, Yvonne Tsang (LBNL, Berkeley, CA)
10:10 am	<i>Coffee Break</i>	

### Gas Hydrates

*Session Chair: George Moridis*

10:40 am	Estimation of Composite Thermal Conductivity of a Heterogeneous Methane Hydrate Sample Using iTOUGH2	Arvind Gupta <sup>1</sup> , Timothy Kneafsey <sup>2</sup> , George Moridis <sup>2</sup> , Yongkoo Seol <sup>2</sup> , Michael Kowalsky <sup>2</sup> , E. D. Sloan <sup>1</sup> ( <sup>1</sup> Colorado School of Mines, Golden, CO; <sup>2</sup> LBNL, Berkeley, CA)
11:05 am	Gas Production by Depressurization from Hypothetical Class 1G and Class 1W Hydrate Reservoirs	Doruk Alp, Mahmut Parlaktuna (Middle Eastern Technical University, Turkey), George Moridis (LBNL, Berkeley, CA)
11:30 am	<i>Luncheon, LBNL Cafeteria</i>	

<b>Wednesday, May 17, 2006, Afternoon Sessions</b>		
<b>Tricks-of-the-Trade</b>		
<i>Session Chair: Yingqi Zhang</i>		
1:00 pm	Participants	TBA
2:30 pm	<i>Coffee Break</i>	
<b>Panel Discussion</b>		
<i>Session Chair: Karsten Pruess</i>		
3:00 pm	Panel Discussion	TBA
4:30 pm	Closing Remarks	Organizing Committee