

# **Geothermal Resources Council**

## **Annual Meeting 2009**

### **(Geothermal 2009)**

**Geothermal Resources Council Transactions Volume 33**

**Reno, Nevada, USA**  
**4-7 October 2009**

**ISBN: 978-1-61567-812-9**

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2009) by the Geothermal Resources Council  
All rights reserved.

Printed by Curran Associates, Inc. (2010)

For permission requests, please contact the Geothermal Resources Council  
at the address below.

Geothermal Resources Council  
P.O. Box 1350  
Davis, California 95617

Phone: (530) 758-2360  
Fax: (530) 758-2839

[grc@geothermal.org](mailto:grc@geothermal.org)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2634  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

## TABLE OF CONTENTS

### **BUSINESS/ECONOMICS**

<b>Competing Interests in a Common Geothermal Resource</b> .....	1
<i>Kevin J. Beaton</i>	
<b>Heating Up the Economy with Geothermal Energy: A Multi-Component Sustainable Development Project at Akutan, Alaska</b> .....	4
<i>A. Kolker, R. Mann</i>	
<b>Private and State Risk Mitigation Programs for Geothermal Exploration Risk</b> .....	9
<i>Horst Kreuter, Christina Schrage</i>	
<b>A New Approach to Total Lost Circulation: An Interwoven Fiber Network to Seal Losses</b> .....	14
<i>Renan Listi, John Tuttle</i>	
<b>Financing Geothermal — The Not So Brave New World</b> .....	16
<i>John McIlveen</i>	
<b>Realizing the Economic Benefit of CDM for Geothermal Energy</b> .....	20
<i>David G. Newell, Dwita Prihantono, Dauly Winnusa, K. Kastoni</i>	
<b>Perspectives on the Economics of Geothermal Power</b> .....	24
<i>Adil Caner Sener, Johan Rene van Dorp, Jesse Dylan Keith</i>	
<b>The Design and Implementation of the Australian Geothermal Reporting Code — A World First Standard Reporting Code for Geothermal Reserves and Resources</b> .....	32
<i>Malcolm Ward, Graeme Beardmore, Anthony Budd, Barry Goldstein, Fiona Holgate, Graham Jeffress, Adrian Larking, Jim Lawless, Peter Reid, Adrian Williams</i>	

### **CASE STUDIES**

<b>Mixing and Dilution Processes at the Las Tres Vírgenes (Méjico) Geothermal Reservoir Indicated by 1997-2007 Geochemical Data</b> .....	36
<i>Rosa María Barragán, Eduardo Iglesias, Rodolfo J. Torres, Víctor Arellano, Neftalí Reyes-Picasso, Miguel Ramírez, Ruth Tapia, Pedro Hernández</i>	
<b>Volcano-Tectonic-Geothermal Interaction at the Hengill Triple Junction, SW Iceland</b> .....	42
<i>B.S. Hardarson, G.M. Einarsson, H. Franzson, E. Gunnlaugsson</i>	
<b>Small-Scale Use of Geothermal Power at Oserian Farms, Naivasha, Kenya</b> .....	48
<i>Stephen Hirsch</i>	
<b>Considerations on the Origin of Acid Fluids in Los Humeros Geothermal Field, Pue., Mexico</b> .....	51
<i>Georgina Izquierdo, Luis C.A. Gutiérrez-Negrín, Alfonso Aragón</i>	
<b>Geothermal Uses and Projects on the Oregon Institute of Technology Campus</b> .....	55
<i>John W. Lund, Tonya "Toni" Boyd</i>	
<b>Turkey — The First Private Geothermal Power Plant</b> .....	61
<i>Gad Shoshan, Umran Serpen</i>	
<b>Maintenance and Operational Experience Gained by Operating the Aluto Langano Geothermal Pilot Power Plant</b> .....	65
<i>Merga Tassew</i>	

### **DRILLING**

<b>Aluminum Alloy Drill Pipes in High Temp Hydrothermal Wells</b> .....	69
<i>Erin R. Anderson</i>	
<b>Foamed Calcium Aluminate Phosphate Cement Enables Drilling and Cementation of California Geothermal Wells</b> .....	75
<i>Brian Berard, Rafael Hernández, Hao Nguyen</i>	
<b>Foamed Latex Slurry and Reverse-circulation Cementing Enable Drilling in Lost-circulation Zones</b> .....	79
<i>Rafael Hernández, Hao Nguyen</i>	
<b>Analysis of Phase Change Materials (PCMs) Used for Borehole Fill Materials</b> .....	83
<i>Lei Haiyan, Zhu Neng</i>	
<b>Geothermal Well Cost Update 2009</b> .....	89
<i>A.J. Mansure, D.A. Blankenship</i>	

<b>Optimizing Geothermal Well Placement: Advantages of a Phased Approach Including Fracture Trace Analysis and Geophysical Techniques</b>	92
<i>Charles D. Race</i>	
<b>Roller Cone Drill Bits for High-temperature Applications in Southern Australia.</b>	96
<i>David Shakhevskoy, Gary Carter, Aaron Dick</i>	

## **EMERGING TECHNOLOGY**

<b>The Penola Project, South Australia: A Unique Hot Sedimentary Aquifer Development, Limestone Coast, South Australia</b>	100
<i>Lambertus De Graaf, Ron Palmer, Ian Reid</i>	
<b>Solar Energy Benefits Southeast Geysers Geothermal Recharge Project</b>	105
<i>S.L. Eneyd, J.M. Rudisill</i>	
<b>Downhole Generator for a Geothermal Injection Well</b>	111
<i>Steven Eneyd, Randy Badger</i>	
<b>Integrated Geothermal &amp; Solar Energy Conversion Technologies and WorleyParsons EcoNomics™ Approach</b>	116
<i>Frank Qun Miao, J. Matthew Dayton, Peter Lardi, Helmy Andrawis</i>	
<b>Global Supply of Clean Energy from Deep Sea Geothermal Resources</b>	121
<i>Jim Shnell</i>	
<b>High Resolution Seismic Velocity Structure in the Reno Basin from Ambient Noise Recorded by a Variety of Seismic Instruments</b>	127
<i>I. Tibuleac, D.H. Von Seggern, J. Louie, J.G. Anderson</i>	

## **ENHANCED GEOTHERMAL SYSTEMS (EGS)**

<b>Interpretation of Reservoir Creation Process at Cooper Basin by Microseismic Multiplet Analysis</b>	131
<i>Hiroshi Asanuma, Yasuhiro Kenmoku, Hiroaki Niitsuma, Doone Wyborn</i>	
<b>Establishing Geothermal Play Systems for 'Hot Rock' Exploration in Australia</b>	136
<i>A.R. Budd, A.C. Barnicoat, B. Ayling, E.J. Gerner, A.J. Meixner, A.M. Kirkby</i>	
<b>Habanero Field Tests in the Cooper Basin, Australia: A Proof-of-concept for EGS</b>	140
<i>Delton Chen, Doone Wyborn</i>	
<b>Toward More Efficient Heat Mining: A Planned Enhanced Geothermal System Demonstration Project</b>	146
<i>Trenton Cladouhos, Susan Petty, Ben Larson, Joe Iovenitti, Bill Livesay, Roy Baria</i>	
<b>Enhanced Heat transfer from Geothermal Systems Using Pressure Cycling</b>	152
<i>Seth Craig, Kent S. Udell</i>	
<b>Regional Geological 3D Model of the Soultz-sous-Forêts Geothermal Field (Rhine Graben, France)</b>	156
<i>C. Dezayes, J. Castera, G. Heilbronn, P. Calcagno</i>	
<b>A Computational Technique for Estimating the Fracture Surface Area Adjacent to a Newly Stimulated Well Within an Engineered Geothermal System</b>	162
<i>Scott Fayer, Peter Rose, Susan Petty, Milind D. Deo, Tianfu Xu</i>	
<b>Hot Rocks Down Under — Evolution of a New Energy Industry</b>	165
<i>Barry Goldstein, A.J. Hill, A. Long, A.R. Budd, B. Ayling, M. Malavazos</i>	
<b>Hydraulic Characteristics of the Basel 1 Enhanced Geothermal System</b>	179
<i>Florentin Ladner, Markus Häring</i>	
<b>Establishing Hot Rock Exploration Models for Australia</b>	184
<i>A.J. Meixner, S.W. Johnston, A.R. Budd, A.M. Kirkby, B. Ayling, E.J. Gerner, A.C. Barnicoat</i>	
<b>Assessment of Fault Reactivation Potential in a Deep Geothermal Reservoir of the Ne-German Basin (Germany)</b>	188
<i>Inga Moeck, G. Kwiatek, Günter Zimmermann, Tobias Backers, Ernst Huenges</i>	
<b>Feasibility Study on Monitoring Enhanced Geothermal Systems Using Electrical Methods</b>	193
<i>Gregory A. Newman, Michael Commer</i>	
<b>Foamed Cementing Geothermal 13 3/8-in. Intermediate Casing: NGP #61-22</b>	195
<i>Kim Niggemann, Abraham Samuel, Alexander Morrissey, Rafael Hernández</i>	
<b>Heat Transfer in HDR System Under Supercritical Conditions</b>	201
<i>Roman I. Pashkevich, Vitaly V. Taskin</i>	
<b>Bringing Down the Cost of EGS Power</b>	206
<i>Susan Petty, Bill Livesay, Matthew Clyne, Roy Baria</i>	

<b>On the Relative Effectiveness of H<sub>2</sub>O and CO<sub>2</sub> As Reservoir Working Fluids for EGS Heat Mining.....</b>	211
<i>John W. Pritchett</i>	
<b>Tracer Testing at the Desert Peak EGS Project.....</b>	217
<i>Peter Rose, Kevin Leecaster, Peter Drakos, Ann Robertson-Tait</i>	
<b>Cost of Electric Power from Enhanced Geothermal Systems — Its Sensitivity and Optimization.....</b>	221
<i>Subir K. Sanyal</i>	
<b>Design and Evaluation of Well Placement and Hydraulic Stimulation for Economical Heat Recovery from Enhanced Geothermal Systems.....</b>	226
<i>Abdul Ravoof Shaik, Joshua Koh, Sheik S. Rahman, Mohammad A. Aghighi, Nam. H. Tran</i>	
<b>Towards a Sustainable Energy Economy: A Roadmap for the Development of Enhanced Geothermal Systems .....</b>	232
<i>Neil Snyder, Mark Antkowiak, Charlie Visser</i>	
<b>Roles and Timing of Onset of Various Thermal-Hydrologic-Mechanical-Chemical Process Couplings in EGS Reservoirs.....</b>	236
<i>Joshua Taron, Derek Elsworth</i>	
<b>Modeling Studies of Single-Well EGS Configurations .....</b>	243
<i>Zhe Wang, Mark W. McClure, Roland N. Horne</i>	
<b>Thermo-Hydro-Mechanical Modelling and Applications for Enhanced Geothermal Reservoirs .....</b>	248
<i>N. Watanabe, W. Wang, C.I. McDermott, B. Zehner, O. Kolditz</i>	
<b>First Tracer Test at Cooper-basin, Australia HDR Reservoir .....</b>	253
<i>Norio Yanagisawa, Peter Rose, Doone Wyborn</i>	
<b>Feasibility Evaluation of an “In-Field” EGS Project at Desert Peak, Nevada.....</b>	257
<i>Ezra Zemach, Peter Drakos, Ann Robertson-Tait</i>	

## **ENVIRONMENTAL**

<b>Unravelling the Subsidence at Wairakei, New Zealand .....</b>	268
<i>Rick Allis, C. Bromley</i>	
<b>Water and Geothermal Energy Development in the Western U.S.: Real World Challenges, Regulatory Conflicts and Other Barriers and Potential Solutions .....</b>	272
<i>Kathleen Callison</i>	
<b>Life Cycle Approach to Understanding Impacts of EGS.....</b>	280
<i>Corrie Clark, Michael Wang, Anant Vyas, John Gasper</i>	
<b>Application of Satellite Interferometry to the Detection of Surface Deformation in the Salton Sea Geothermal Field, California.....</b>	284
<i>Mariana Eneva, Giacomo Falorni, David Adams, Jacopo Allievi, Fabrizio Novati</i>	
<b>Fluid Extraction in the Cerro Prieto Geothermal Field and the Slip on Saltillo Fault .....</b>	289
<i>Ewa Glowacka, O. Sarychikhina, F. Suarez, A. Nava, F. Farfan, G. Diaz De Cossio Batani, A. Garcia, M. Guzman</i>	
<b>Developing Geothermal Resources on Public Lands: Fast Cash, Slow Permits .....</b>	293
<i>Laura Smith Morton</i>	
<b>Relationship of Pore Pressure to Large Microseismic Events During Hydraulic Stimulation at Basel, Switzerland, in 2006.....</b>	298
<i>Yusuke Mukuhira, Hiroshi Asanuma, Hiroaki Niitsuma, Markus Häring, Nicholas Deichmann</i>	
<b>Management of Significant Environmental Aspects of Geothermal Projects.....</b>	303
<i>Endy Kevin Padilla, Luis Alberto Franco</i>	
<b>Hydrogen Sulfide and Mercury Abatement: Development and Successful Operation of AMIS Technology .....</b>	308
<i>Fabio Sabatelli, Massimo Mannari, Roberto Parri</i>	
<b>Permitting Geothermal Exploration and Development Projects on Public and Tribal Lands.....</b>	313
<i>Alan Waltner</i>	

## **EUROPEAN**

<b>30 Years of Exploitation of the Geothermal Resource in Paris Basin for District Heating .....</b>	316
<i>Fabrice Boissier, Simon Lopez, Alain Desplan, Hervé Lesueur</i>	
<b>The Current Status of Geothermal Resources in Italy and Potential for 2020 .....</b>	321
<i>Giorgio Buonasorte, Raffaele Cataldi, A. Manzella, Giancarlo Passaleva</i>	

<b>Three-dimensional Estimation of Geothermal Potential from Geological Field Data: The Limagne Geothermal Reservoir Case Study (France).....</b>	326
<i>P. Calcagno, C. Baujard, A. Dagallier, L. Guillou-Frottier, A. Genter</i>	
<b>Structural Controls on Geothermal Systems in Western Turkey: A Preliminary Report .....</b>	334
<i>James E. Faulds, V. Bouchot, Inga Moeck, Karem Oguz</i>	
<b>The Geothermal Resources of Iceland .....</b>	341
<i>Ólafur G. Flóvenz, Benedikt Steingrimsson</i>	
<b>The EGS Soultz Project (France): From Reservoir Development to Electricity Production .....</b>	346
<i>A. Genter, K. Evans, N. Cuenot, F. Baticci, L. Dorbath, J. Graff, B. Sanjuan</i>	
<b>Geothermal Resources in the German Basins .....</b>	352
<i>P. Herzberger, T. Kölbel, W. Münch</i>	
<b>Geothermal Resources in Spain (Basin, Volcanics and EGS) .....</b>	355
<i>R. Hidalgo, Jose Sánchez Guzmán, Victor Guerrero, Celestino García De La Noceda</i>	
<b>The EGS-Project Groß Schönebeck — Current Status of the Large Scale Research Project in Germany.....</b>	358
<i>Ernst Huenges, Kemal Erbas, Inga Moeck, Guido Blöcher, Wulf Brandt, Thomas Schulte, Ali Saadat, G. Kwiatek, Günter Zimmermann</i>	
<b>The Deep Roots of the Larderello Geothermal Field (Italy) from Heat Flux and <math>^3\text{He}</math> Anomalies .....</b>	360
<i>Gabriella Magro, Stefano Bellani, Bruno Della Vedova</i>	
<b>The Iceland Deep Drilling Project: Stable Isotope Constraints of Fluid Source and Evolution in Icelandic Geothermal Systems.....</b>	366
<i>Emily C. Pope, Dennis K. Bird, Stefán Arnórsson, Thráðinn Fridriksson, Wilfred A. Elders, Guðmundur Ó. Fridleifsson</i>	
<b>Lithosphere Tectonics and Thermo-mechanical Properties: An Integrated Modeling Approach for Enhanced Geothermal Systems Exploration in Europe .....</b>	372
<i>J.D. Van Wees, S. Cloetingh, P.A. Ziegler, L. Lenkey, F. Beekman, M. Tesauro, A. Förster, B. Norden, M. Kaban, N. Hardebol, M. Ter Voorde, E. Willingshofer, T. Cornu, D. Bonté</i>	

## **EXPLORATION**

<b>Active Fault Controls at High-Temperature Geothermal Sites: Prospecting for New Faults.....</b>	377
<i>John W. Bell, Alan R. Ramelli</i>	
<b>Thermal Modeling of an Area West of the Mt. Amiata Geothermal Field, Italy .....</b>	382
<i>Stefano Bellani, Fabrizio Gherardi</i>	
<b>Body Wave Tomography for Regional Scale Assessment of Geothermal Indicators in the Western Great Basin.....</b>	387
<i>Glenn Biasi, Leiph Preston, I. Tibuleac</i>	
<b>Why Basin and Range Systems are Hard to Find II: Structural Model of the Producing Geothermal System in Dixie Valley, Nevada .....</b>	391
<i>David Blackwell, Richard P. Smith, Al Waibel, Maria Richards, Patrick Stepp</i>	
<b>Exploration Guides for Active High-Temperature Geothermal Systems as Modern Analogs for Epithermal Paleosystems .....</b>	397
<i>V. Bouchot, A. Genter</i>	
<b>Integrated Geophysical Exploration Methods at European Sites — Results From the I-GET Project.....</b>	404
<i>David Bruhn</i>	
<b>Carbonate Tufa Columns as Exploration Guides for Geothermal Systems in the Great Basin.....</b>	409
<i>Mark Coolbaugh, Paul Lechner, Christopher Sladek, Chris Kratt</i>	
<b>Importance of Elevation and Temperature Inversions for the Interpretation of Thermal Infrared Satellite Images Used in Geothermal Exploration .....</b>	415
<i>Mariana Eneva, Mark Coolbaugh</i>	
<b>Geochemical Evidence of a Geothermal Power Resource in the Canadian Rockies: Canoe Hot Springs, British Columbia.....</b>	419
<i>Mory M. Ghomshei, Sarah J. Kimball, Soheil Porkail</i>	
<b>A Study of the Surprise Valley Fault Using a High-Resolution Shallow Seismic Reflection Profile.....</b>	424
<i>Annie Kell-Hills, M. Thompson, M. Dhar, J. Louie, S. Pullammanappallil</i>	
<b>Identification of a New Blind Geothermal System with Hyperspectral Remote Sensing and Shallow Temperature Measurements at Columbus Salt Marsh, Esmeralda County, Nevada .....</b>	428
<i>Christopher Kratt, Mark Coolbaugh, Bill Peppin, Chris Sladek</i>	

<b>Risks and Opportunities of a Geothermal Exploration Project in the Pannonian Basin in Central-Eastern Europe .....</b>	433
<i>Attila Kujbus</i>	
<b>Multi-Gas Geochemistry at the Desert Queen Geothermal System, West-Central Nevada .....</b>	436
<i>Paul Lechler, Mark Coolbaugh, Chris Sladek</i>	
<b>Remote Sensing for Geothermal Exploration Over Buffalo Valley, NV .....</b>	440
<i>Elizabeth Littlefield, Wendy Calvin</i>	
<b>Joint Geophysical Imaging of Poroperm Distributions in Fractured Reservoirs.....</b>	445
<i>Peter Malin, Peter Leary, Eylon Shalev, Stephen Onacha</i>	
<b>Rapid Exploration of the Tolhuaca Prospect, Southern Chile.....</b>	449
<i>Glenn Melosh, William Cumming, David Sussman, Dick Benoit, Elizabeth Soto, Anna Colvin, Max Wilmarth, Jeff Winick, Luis Fredes</i>	
<b>A Preliminary Analysis of Geothermal Resources in the Central Raton Basin, Colorado, from Bottom-Hole Temperature Data.....</b>	453
<i>Paul Morgan</i>	
<b>Geothermal Site Acquisition and Early Development: Key Legal Issues and Emerging Strategies.....</b>	458
<i>Peter Mostow, Andrew Braff</i>	
<b>Joint Geophysical Imaging of Fluid-Filled Fracture Zones in Geothermal Fields in the Kenya Rift Valley .....</b>	465
<i>Stephen Onacha, Eylon Shalev, Peter Malin, Peter Leary</i>	
<b>Classical Geothermal Studies — The Pre-Feasibility Phase .....</b>	472
<i>Bjarni Richter, Benedikt Steingrimsson, Magnus Olafsson, Ragna Karlsson</i>	
<b>Improvements in Shallow (Two-Meter) Temperature Measurements and Data Interpretation .....</b>	475
<i>Chris Sladek, Mark Coolbaugh, Christopher Kratt</i>	
<b>Some Indications of Geothermal Potential in the Green River Soda Springs Area, Cowlitz County, Washington .....</b>	482
<i>D.H. Vice</i>	
<b>Exploration at the Reese River Geothermal Prospect in Nevada .....</b>	487
<i>Jeffrey B. Witter, Joel A. Ronne, Gary R. Thompson</i>	

## **HEAT PUMP**

<b>Simulation of a Geothermal Heat Pump System with an Expander-Driven Primary Pump .....</b>	492
<i>Hiroshi Asanuma, Koji Ono, Hiroaki Niitsuma</i>	
<b>Trends in GeoExchange Technology .....</b>	495
<i>Warren (Trey) A. Austin III</i>	
<b>Geothermal Heating and Cooling System Design Process.....</b>	497
<i>John D. Geyer</i>	
<b>In-Situ Thermal Conductivity Testing for Ground-coupled Heat Exchangers .....</b>	499
<i>John D. Geyer</i>	
<b>Geothermal (Ground-Source) Heat Pumps: Market Status, Barriers to Adoption, and Actions to Overcome Barriers .....</b>	502
<i>Patrick J. Hughes</i>	
<b>Federal and State Geothermal Heat Pump Incentives.....</b>	506
<i>John Kelly</i>	
<b>Geothermal Heat Pump Market and Business Models, Or “So You Think You Want to Be in the Geothermal Heat Pump Business?” .....</b>	509
<i>John Kelly</i>	
<b>Numerical Simulation on Heat Transfer Performance of Vertical Borehole Heat Exchangers in a Fractured Medium.....</b>	512
<i>Seong-Kyun Kim, Gwang-Ok Bae, Yoonho Song, Kang-Kun Lee</i>	
<b>Research of Aquifer Thermal Energy Storage System Integrated Underground Water Heat Pump .....</b>	516
<i>Xueling Liu</i>	
<b>Canby’s Geothermal Laundromat .....</b>	520
<i>Dale Merrick</i>	
<b>The Project Negatherm Report .....</b>	524
<i>Dennis Murphy</i>	
<b>CO<sub>2</sub> Emission Mitigation by Geothermal Development — Especially with Geothermal Heat Pumps.....</b>	528
<i>L. Rybach</i>	

<b>An Experimental Study of the Effect of Groundwater Flow on the Thermal Performance of Borehole Heat Exchangers .....</b>	532
<i>Huajun Wang, Chengyong Qi, Hongpu Du, Jihao Gu</i>	

## **INTERNATIONAL**

<b>Geothermal Systems in India.....</b>	536
<i>Varun Chandrasekhar, D. Chandrasekharam</i>	
<b>The Iceland Deep Drilling Project (IDDP): Deep Drilling at Krafla to Investigate Supercritical Geothermal Resources.....</b>	540
<i>Wilfred A. Elders, Gudmundur Ó. Fridleifsson</i>	
<b>Geothermal Energy: A Secure Resource for Development of Ladakh Region, India.....</b>	545
<i>Mohan L. Gupta</i>	
<b>IEA-GIA-International Geothermal Cooperation — Going from Strength to Strength .....</b>	551
<i>M.A. Mongillo, C. Bromley, L. Rybach</i>	
<b>Tapping Into Canada's Geothermal Potential .....</b>	556
<i>Alison thompson</i>	

## **LATE BREAKING NEWS PANEL**

<b>Considerations in the Testing and Selection of Materials for Corrosive Geothermal Environments.....</b>	558
<i>Bill Amend</i>	
<b>Squeeze with Foamed Cement Cuts Nonproductive Time in a Geothermal Well .....</b>	563
<i>Dennis Lovett, Rafael Hernández, Lyndon Chandarjit</i>	
<b>Seasonal Underground Thermal Energy Storage Using Smart Thermosiphon Technology .....</b>	567
<i>Kent S. Udell, Phil Jankovich, Bidzina Kekelia</i>	
<b>Application of Electrical Submersible Pumping Systems in High Temperature Geothermal Environments .....</b>	572
<i>Joe Vandevier, Ben Gould</i>	
<b>Diamond-Hardfaced Carbide/Metal Composites for Submersible-Pump Bearings in Geothermal Wells .....</b>	576
<i>O.A. Voronov, B.H. Kear</i>	

## **OIL AND GAS**

<b>Initial Implementation of Oil Field Temperature Data for Calculating Formation Specific Heat content for Electric Power Generation: First Approximations.....</b>	581
<i>Richard J. Erdlac Jr.</i>	
<b>Electric Power Generation Using Geothermal Fluid Coproduced from Oil and/or Gas Wells.....</b>	590
<i>Bernie Karl, Ian-Michael Hebert, Jesse Warwick</i>	
<b>Feasibility of Geothermal Power Generation from Petroleum Wells.....</b>	592
<i>Subir K. Sanyal, Steven J. Butler</i>	
<b>ThermoGIS: An Integrated Web-based Information System for Geothermal Exploration and Governmental Decision Support for Mature Oil and Gas Basins.....</b>	599
<i>J.D. Van Wees, Joaquim Juez-Larre, Harmen Mijnlieff, Alexander Kronimus, Serge Van Gessel, Leslie Kramers, Arie Obdam, Hanneke Verweij, D. Bonté</i>	

## **POWER PLANT**

<b>Modeling and Analysis of Sub- and Supercritical Binary Rankine Cycles for Low- to Mid-Temperature Geothermal Resources .....</b>	604
<i>Chad Augustine, Randall Field, Ronald Dipippo, Gianluca Gigliucci, Irene Fastelli, Jeff Tester</i>	
<b>Nano-Structured Calcium Silicate — A Solution to the Formation of Silica Scale in Geothermal Water .....</b>	609
<i>Thomas Borrmann, James H. Johnston, Robert Mcbrearty</i>	

<b>Understanding Plant External Conditions When Designing Geothermal Power Plants — Some Important Considerations.....</b>	613
<i>Douglas P. Bouche</i>	
<b>Repowering Steamboat 2 and 3 Plants with New Axial Flow Turbines .....</b>	616
<i>Tom Buchanan, Wade Posten, Sean Berryman</i>	
<b>Evaluation of Pressure-Driven and Novel Membrane Processes for Treatment of Geothermal Brines.....</b>	623
<i>Amy E. Childress, Mirinda Hutton, Tzahi Y. Cath, Nathan Walker, Eyal Hen</i>	
<b>Principles of Modularity and Redundancy Assessed in High Reliability Geothermal Generation.....</b>	627
<i>Roger Hill, Valerie Peters, William Glassley</i>	
<b>Technical Features of Kawerau Geothermal Power Station, New Zealand.....</b>	632
<i>Tadao Horie, Toshie Muto, Tony Gray</i>	
<b>Enhancing Condensers for Geothermal Systems: The Effect of High Contact Angles on Drop Wise Condensation Heat Transfer.....</b>	637
<i>John M. Kennedy, Sunwoo Kim, Kwang J. Kim</i>	
<b>Centrifugal Steam-Water Separators .....</b>	642
<i>Arthur H. Krugler</i>	
<b>Optimizing Binary Cycles in Radial Inflow Turbines .....</b>	645
<i>Frédéric Marcuccilli, Damien Thiolet</i>	
<b>The Lemelson Meeting: Scoping the Design Criteria for the Global Geothermal Challenge.....</b>	652
<i>Lawrence Molloy, Michael Lindsay, Patrick Maloney</i>	
<b>Sustainable Development Strategy for Geothermal Resources in El Salvador.....</b>	656
<i>Manuel Monterrosa, Natalia Zepeda</i>	
<b>Use of Small, Sub 1 MW Organic Rankine Cycle Power Systems and Low Temperature Resources.....</b>	660
<i>Josh Nordquist</i>	
<b>Germencik: A Thoroughly Modern Flash Plant in Turkey .....</b>	666
<i>Kevin Wallace, Tim Dunford, Marshall Ralph, William Harvey</i>	
<b>New Turbines to Enable Efficient Geothermal Power Plants .....</b>	672
<i>Phil Welch, Patrick Boyle</i>	
<b>Design and Construction of Wayang Windu Unit 2 Geothermal Power Station.....</b>	680
<i>Naoko Yamaguchi</i>	
<b>High-Flux Boiling/Evaporation of Isopentane from a Structured-Porous Fin .....</b>	685
<i>Zenghui Zhao, R.A. Wirtz</i>	

## **RESERVOIR ENGINEERING**

<b>Analysis of Well Productivity As Related to Changes in Well Damage .....</b>	692
<i>Alfonso Aragón, Georgina Izquierdo, Víctor Arellano</i>	
<b>Review of Well Stimulation Operations in Iceland .....</b>	697
<i>Gudni Axelsson, Sverrir Thórhallsson</i>	
<b>Investigation of Mobility Changes During Water Injection/Fall Off Test in Liquid Dominated Geothermal Reservoirs.....</b>	703
<i>Abbas Azarkish</i>	
<b>Initial Thermal State of the Los Azufres Geothermal Reservoir .....</b>	707
<i>Alfonso García-Gutiérrez</i>	
<b>A Steam-tracer Study in the Maritaro-Laguna Verde Area of the Los Azufres (Mexico) Geothermal Field .....</b>	713
<i>Eduardo Iglesias, Magaly Flores Armenta, José Luis Quijano León, Marco A. Torres Rodríguez, Rodolfo J. Torres, Neftalí Reyes Picasso, Miguel Ramírez Montes, Fernando Sandoval Medina</i>	
<b>Privatization of Kizildere Geothermal Power Plant and Current Approaches for the Field and Plant.....</b>	717
<i>Ali Kindap, Tevfik Kaya, Füsun Tut</i>	
<b>Towards Inter-well Connectivity Maps for Reservoir Flow Structure — Modeling with a Physics-based, Computationally-Friendly Approach to Geofluid Flow in Fracture-Heterogeneous Reservoirs .....</b>	722
<i>Peter Leary, Peter Malin</i>	
<b>Characteristics of the Matalibong Steam Zone, Tiwi Geothermal Field, Philippines .....</b>	727
<i>Anthony Menzies, Larry Villaseñor, Eugene Sunio, Wilhelmino Lim</i>	
<b>Calibration of Mathematical Models for Heat and Mass Transfer in Thermal Soils .....</b>	733
<i>J.A. Newson, M.J. O'sullivan</i>	
<b>Conceptual Modeling and Tracer Testing at Ribeira Grande, São Miguel, Azores, Portugal.....</b>	739
<i>Carlos Ponte, Rui Cabeças, Graça Rangel, Rita Martins, Chris Klein, Minh Pham</i>	

<b>Numerical Modeling for Resource Management at Ribeira Grande, São Miguel, Azores, Portugal</b>	746
<i>Carlos Ponte, Rui Cabeças, Rita Martins, Graça Rangel, Minh Pham, Chris Klein</i>	
<b>Spatial Variation of High Temperature Hydrothermal Activity at Mokai Geothermal Field, Taupo Volcanic Zone, New Zealand</b>	753
<i>L.E. Ramirez, A.J. Rae, C. Bardsley, G. Bignall</i>	
<b>Recent Developments in Fiber Optic Sensor Technology for High Temperature Well Monitoring</b>	756
<i>Paul E. Sanders, Trevor W. Macdougall</i>	
<b>Geothermal Power from Wells in Non-convective Sedimentary Formations — An Engineering Economic Analysis</b>	761
<i>Subir K. Sanyal, Steven J. Butler</i>	
<b>Results of the First Application of Perfluorocarbons and Alcohols in a Multi-Well Vapor and Two-Phase Tracer Test at the Darajat Geothermal Field, Indonesia, and Implications for Injection Management</b>	767
<i>Arias Sugandhi, Paul N. Hirtz, Purwantoko Mahagyo, Gregg A. Nordquist, Krisnendar Martiady, Jeffrey W. Roberts, Russell J. Kunzman, Mike C. Adams</i>	
<b>Propagation of the Cooled Region in a Small Fractured Geothermal Reservoir</b>	775
<i>Aniko Toth, Elemer Bobok</i>	
<b>Sustainable Geothermal Reservoir Management Practice</b>	780
<i>P. Ungemach, Miklos Antics, Pierre Lalos</i>	
<b>Thermodynamic Properties of Pure Water with an Approach of Multi Input Variable Sets</b>	787
<i>Mahendra P. Verma</i>	

## **RESOURCE ASSESSMENT**

<b>New Geothermal Resource Findings Around the Menderes Massif in the Western Anatolia, Turkey</b>	793
<i>Ali Ünal Akman, Özgür Çağlan Kuyumcu, Seyhan Önç, Umut Z. Destegül, Volkan Baydar, İlker Vural, Kadir Balci, Selen Cuhadar</i>	
<b>The Geothermal Potential of Clarke Lake and Milo Gas Fields, Northeast British Columbia, Canada</b>	799
<i>Nastaran Arianpoo, Mory M. Ghomshei, John A. Meech</i>	
<b>Geothermal Discovery Near Corner Canyon, Salt Lake County, Utah</b>	803
<i>Robert E. Blackett, J. Lucy Jordan, Kevin Thomas, Janae Wallace, Robert F. Biek</i>	
<b>A Preliminary Conceptual Model for the Blue Mountain Geothermal System, Humboldt County, Nevada</b>	809
<i>John Casteel, Rogel Trazona, Glenn Melosh, Kim Niggemann, Brian Fairbank</i>	
<b>Heat Flow Density Estimations in the Portuguese Northern Hercynian Massif Using Silica Geothermometry</b>	813
<i>Antonio Correia, Elsa C. Ramalho</i>	
<b>Geothermal REC Contracts — Issues and Solutions in Today's Market</b>	817
<i>Nicole Fabri</i>	
<b>The Relationship Between Resistivity and Mineralogy at Travale, Italy</b>	821
<i>C. Giolito, G. Ruggieri, A. Manzella</i>	
<b>Deep Geothermal Energy Potential in the Madrid Basin</b>	826
<i>R. Hidalgo, J. Sánchez, P. Ungemach</i>	
<b>The Reykjanes Geothermal System: Alteration Mineralogy and Fluid-Rock Interaction in an Icelandic High Temperature System</b>	829
<i>Naomi Marks, Peter Schiffman, Robert Zierenberg</i>	
<b>Computational Fluid Dynamic Techniques for Validating Geothermal Separator Sizing</b>	833
<i>Alan R. Pointon, Tracy D. Mills, Gregory J. Seil, Qihong Zhang</i>	
<b>Geochemistry of Buried Rhyolite Lavas, Western Steamfield, Wairakei Geothermal Field, Taupo Volcanic Zone, New Zealand</b>	839
<i>L.E. Ramirez, A.J. Rae, G. Bignall</i>	
<b>Eastern Texas Geothermal Mapping</b>	843
<i>Maria Richards, Patrick Stepp, David Blackwell, Ramsey Kweik</i>	
<b>Where the Barnett Ends — A Study of the Geothermal Potential in Dallas County, Texas</b>	849
<i>Andrés Ruzo, David Blackwell, Maria Richards</i>	
<b>Prospects of Geothermal Power Industry Development in the South Kamchatka: Koshelevskaya Hydrothermal-Magmatic System</b>	857
<i>S. Rychagov, A. Nuzhdayev</i>	

<b>Severo-Paramushirskaya Hydrothermal-Magmatic System: Interaction of Modern Volcano Ebeko, Severo-Kurilsky Geothermal Deposit and Metallogenic Fluids.....</b>	862
<i>S. Rychagov, V. Belousov, T. Kotenko, L. Kotenko</i>	
<b>Statewide Geothermal Resource Mapping in Colorado .....</b>	867
<i>Matthew A. Sares, Frederick E. Berkman, Nicholas A. Watterson</i>	
<b>Oregon Geothermal Development.....</b>	872
<i>Alex Sifford</i>	
<b>Dacite Melt at the Puna Geothermal Venture Wellfield, Big Island of Hawaii .....</b>	876
<i>William Teplow, Bruce Marsh, Jeff Hulen, Paul Spielman, Mike Kaleikini, David Fitch, William Rickard</i>	
<b>Quantifying the Undiscovered Geothermal Resources of the United States .....</b>	882
<i>Colin F. Williams, Marshall J. Reed, Jacob DeAngelo, S. Peter Galanis Jr.</i>	

## **UTILITY/TRANSMISSION**

<b>Utility Leadership Roles in Promoting More Cost-Effective Energy Efficiency Programs.....</b>	890
<i>Paul Bony</i>	
<b>Developing an Enhanced Geothermal System Resource in East-Central Arizona.....</b>	893
<i>Dennis W. Hughes</i>	
<b>Geothermal Assessment As Part of California's Renewable Energy Transmission Initiative (RETI) .....</b>	896
<i>James Lovekin, Ryan Pletka</i>	
<b>Utility Geothermal Working Group 2009 Update .....</b>	902
<i>Guy Nelson</i>	
<b>Sacramento Municipal Utility District: Strategy for 37% Renewable Energy by 2020.....</b>	906
<i>Elaine Sison-Lebrilla</i>	
<b>Transmission Access and Interconnection — Essential Ingredients to Successful Integration of Geothermal Energy .....</b>	909
<i>Erik J. A. swenson, Rabeha Kamaluddin</i>	

## **VAPOR DOMINATED**

<b>3D Seismic for the Deep Exploration of the Travale Geothermal Field (Italy): I-GET Project Results.....</b>	915
<i>M. Casini, Simonetta Ciuffi, A. Fiordelisi, Alfredo Mazzotti, Iris Perticone, Elio Spinelli, Eusebio Stucchi</i>	
<b>Numerical Model of the Travale Geothermal Field (Italy) in the Framework of the I-GET European Project.....</b>	920
<i>M. Cei, A. Barelli, M. Casini, P. Romagnoli, R. Bertani, A. Fiordelisi</i>	
<b>Simulation of the Steam Pipeline Network in the Monteverdi Geothermal Field .....</b>	925
<i>M. Ciurli, A. Barelli</i>	
<b>Injection Returns and Evolution of Non-condensable Gases at the NCPA Geysers Wellfield, California.....</b>	931
<i>Chris Klein, Steven Enedy, Steven J. Butler, James W. Morrow</i>	
<b>Wellfield / Powerplant Coordinated Control to Minimize Emissions .....</b>	938
<i>Tom McAuliffe</i>	
<b>Design and Implementation of Steam Supply for the Western Geopower Unit 1 Project at the Geysers Geothermal Field, California.....</b>	942
<i>Subir K. Sanyal, R.C. Henneberger, E.E. Granados, M. Long, K. Macleod</i>	
<b>Author Index</b>	