University of Nevada, Reno

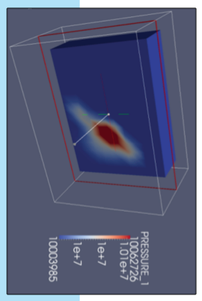
DOE Project EE-0003997

Expanding geothermal resource utilization through directed research, education, and public outreach

September 30, 2010 to December 31, 2015

GREAT BASIN CENTER FOR Geothermal Energy

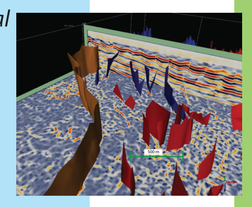
Research: Faculty Seed Grants



Utilization of thermal-hydrologic-mechanical-chemical coupled modeling to investigate fracture network permeability evolution during enhanced geothermal system stimulation at Desert Peak, Nevada

PI Matt Reeves, Desert Research Institute

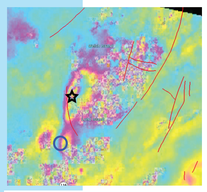
Characterized site (including fracture network and fracture permeability), formed conceptual model of shear failure in low-pressure phase of EGS experiment and successfully tested this conceptual model with a hydro-mechanical coupled model (FLAC3D).



Understanding downhole geophysics in volcanic basins: Knowledge transfer from New Zealand's Geothermal Institute

PI John Louie, Nevada Seismological Lab, UNR

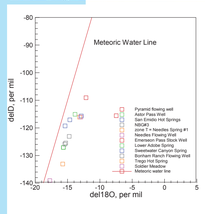
We are searching for a "geothermal seismic signature" that will enable improved geothermal drilling success, lowering the risk and cost of geothermal-power development. We correlated borehole data against seismic images of Nevada geothermal prospects.



Reconnaissance InSAR and GPS surface deformation analysis of Salt Wells and Stillwater geothermal areas

PI's Bill Hammond and John Bell, Nevada Bureau of Mines and Geology

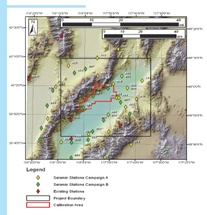
Map extent and temporal changes in subsidence from pumping associated with Stillwater and Salt Wells geothermal plants. Use this information to assess structural controls on reservoir geometry and impact of withdrawal.



Noble gas and isotopic analysis to delineate subsurface flow patterns north of Pyramid Lake, Nevada

PI Clay Cooper, Desert Research Institute

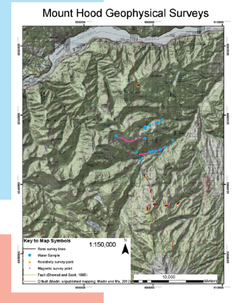
Fluids discharging from the flowing wells at the Needle Rocks area may be from recharge in nearby mountains; sampling of dissolved noble gases, environmental isotopes, major ions, and carbon-14 will help determine if the fluids are derived from a common source, and the extent of subsurface mixing.



Crustal attenuation and stochastic properties as geothermal favorability indicators

PI Ileana Tibuleac, Nevada Seismological Lab, UNR

Investigating seismic attenuation and crustal stochastic properties as indicators of Enhanced Geothermal System (EGS) favorability as a new approach that is more sensitive to changes in crustal heterogeneity than velocity.



Testing methods for geothermal exploration in the Pacific Northwest

PI Patrici Cashman, Dept. Geological Sciences and Engineering

The goal was to test the efficacy of three geophysical methods (shallow magnetic, resistivity and shallow ReMi™) for fault recognition and geothermal exploration in the Pacific Northwest. All geophysical data were evaluated, with useful results.

Education: Graduate Student Research Projects

Paul Schwering, MS Geophysics, May 2013
Geophysical Modeling of the Dixie Meadows Geothermal Prospect: Dual Analysis of Gravity and Magnetic Data towards Identifying Structural Controls
Thesis Advisor: Bob Karlin, Dept. of Geological Sciences

Tyler Kent, MS Geophysics, May 2013,
Comparing deformation at Soda Lake geothermal field from GPS and 3D seismic
Thesis Advisor: John Louie, Nevada Seismological Lab

Sabina Kraushaar, MS Geology, May 2014
Structural Controls of the MacFarlane Geothermal System, Humboldt County, Nevada: New Insights Based on Detailed Geologic Mapping, Shallow Temperature Surveys, and Magnetic Data
Thesis Advisor: Patricia Cashman, Dept. of Geological Sciences

Lyndsay Hazelwood, MS Geology, Dec 2014
Structural Controls of the Geothermal System at Gerlach, Washoe County, Nevada
Thesis Advisor: Patricia Cashman, Dept. of Geological Sciences

Danielle Molisee, MS Geology, expected May 2015
Structural and temporal constraints at Buffalo Valley Hot Springs and proximal young volcanics, north-central, Nevada
Thesis Advisor: John Bell, Nevada Bureau of Mines and Geology

Nicholas Paasche, MS Hydrogeology, expected Aug 2015
A Sensitivity Analysis of the Parameters Controlling Heat Flow in a Geothermal Reservoir
Thesis Advisor: Clay Cooper, Desert Research Institute

Andrew Sadowski, MS Geology, expected Dec 2015
Structural controls of the Black Warrior geothermal system, Truckee Range, Washoe County, Nevada
Thesis Advisor: Jim Faulds, Nevada Bureau of Mines and Geology

Research Scientists

Post Doctoral Scholar, Drew Siler, Nov-Dec, 2011 and Jan – Dec 2013
3D modeling of Basin and Range systems at Brady's, Astor Pass, Emerson Pass, and San Emidio. Analysis of stress provinces and slip and dilation tendencies throughout the Great Basin.

Research Scientist, Betsy (Littlefield) Pace, Jan 2012 – Dec 2014
Spectroscopic analysis of remote and in-situ data for mapping temperature dependent alteration minerals relevant to geothermal exploration. Use of commercial and NASA sensors from aircraft and satellites and field spectrometers on drill core.

Exploration and Databases

- Detailed analysis and assessment of regional and local resources.
- Geological, Geochemical and Geophysical Analysis and Interpretation
- Structural mapping
- 2D/3D seismic surveys
- Geodetic analysis of crustal strain
- Geochemical analysis of soil gasses
- Geochemical analysis of spring and well geothermometers
- Remote data analysis for Quaternary faults
- Mineral spectroscopy for hydrothermal alteration
- Real-time seismic monitoring of active reservoirs
- MEQ assessment of induced seismic hazards.

http://www.unr.edu/geothermal/ or http://www.gbcge.org/

http://www.nbmg.unr.edu/Geothermal/

Publications

Calvin, W. M., E. F. Littlefield, and C. Kratt (2015), Remote sensing of geothermal-related minerals for resource exploration in Nevada, *Geothermics*, 53, 517-526.

Cashman, P.H., C.D. Peterson, J.N. Louie, S.K. Pullammanappallil, A. Pancha, C. Sladek, and L.T. West (2013), Testing methods for geothermal exploration in the Pacific Northwest, *Geothermal Resources Council Transactions, 37*, 237-247.

Cooper, C.A., J. M. Thomas, B.F. Lyles, D.M. Reeves, G.M. Pohll, and R. Parashar (2012), A preliminary geochemical description of the geothermal reservoir at Astor Pass, northern Pyramid Lake, Nevada, *Geothermal Resources Council Transactions, 36*, 37-40.

Faulds, J.E., N.H. Hinz, G.M. Dering, and D.L. Siler (2013), The hybrid model – The most accommodating structural setting for geothermal power generation in the Great Basin, western USA, *Geothermal Resources Council Transactions, 37*, 3-10.

Hammond, W.C., and J.W. Bell (2013), Structural controls on geothermal reservoir deformation at Stillwater, Nevada from InSAR and GPS data, *Geothermal Resources Council Transactions, 37,* 11-15.

Hazelwood, L.A., P.H., Cashman, and J.E. Faulds (2013), Structural controls on the geothermal system at Gerlach, Washoe County, NV, *Geothermal Resources Council Transactions,* 37, 463-467.

Hinz, N.H., J.E. Faulds, and D.L. Siler (2013), Developing systematic workflow from field work to quantitative 3D modeling for successful exploration of structurally controlled geothermal systems, *Geothermal Resources Council Transactions, 37*, 275-279.

Kent, T., J. Louie, and J. Echols (2013), Correlating azimuthal anisotropy to geothermal resource potential using a 3D-3C seismic survey of Soda Lake geothermal field, Nevada, *SEG Technical Program Expanded Abstracts* 2013, 341-346, http://library.seg.org/doi/abs/10.1190/segam2013-1398.1.

Kent, T., and J. Louie (2013), Tectonic deformation of a lacustrine mudstone at Soda Lake geothermal field, western Nevada, USA, From 3D seismic interpretation, *35th New Zealand Geothermal Workshop Proceedings*.

Kraushaar, S.M., and P.H. Cashman (2013), Structural controls of the MacFarlane geothermal system, Humboldt County, Nevada: A progress report, *Geothermal Resources Council Transactions, 37*, 17-23.

Littlefield, E., and W. Calvin (2014), Geothermal exploration using imaging spectrometer data over Fish Lake Valley, Nevada, *Remote Sensing of Environment*, 140, 509-518, http://dx.doi.org/10.1016/j.rse.2013.09.007.

Littlefield, E.,W. Calvin, P. Stelling, and T. Kent (2012), Reflectance spectroscopy as a drill core logging technique: An example using core from the Akutan exploration project, *Geothermal Resources Council Transactions, 36,* 1281-1283.

Louie, J.N., Pullammanappallil, S., and W. Honjas, 2011, Advanced seismic imaging for geothermal development, *New Zealand Workshop 2011 Proceedings.*

Schwering, P.C. and R.E. Karlin (2012), Structural interpretation and modeling of the Dixie Meadows geothermal prospect using gravity and magnetic data, *Geothermal Resources Council Transactions, 36,* 53-58.

Siler, D.L., B.M. Mayhew, and J.E. Faulds (2012), Three-dimensional geologic characterization of geothermal systems: Astor Pass, Nevada, USA, *Geothermal Resources Council Transactions, 36,* 783-786.

Siler, D.L., and J.E. Faulds (2013), Three-dimensional geothermal fairway mapping: Examples from the western Great Basin, USA, *Geothermal Resources Council Transactions, 37,* 327-332.

Tibuleac, I.M., S. Pullammanappallil, J. Faulds, and H. McLachlan (2012), Development of a low cost method to estimate the seismic signature of a geothermal field from ambient seismic noise analysis, *Geothermal Resources Council Transactions, 36,* 1023-1028.

Collaborative and Support Activities

National Geothermal Academy: This award provides some support for staff for logistics coordination and organization to run the summer course.

NSF Sponsored Joint US-New Zealand Geothermal Workshop, spring 2012

NSF Industry-University Collaborative Research Center in Geothermal Resources (not ultimately funded)

Geothermal Technologies Office Geothermal Vision Study

Peer review for annual Geothermal Resources Council conference papers

Peer review for Geothermal Technologies office projects

UNR Faculty and student study trip to Iceland, Aug 2013

Exhibits at GEO Expo and Geothermal Summits

Hosted EPRI workshop on EGS (2012)

Geothermal sessions at other scienctific meetings (AGU, GSA)