



**Expanding Geothermal Resource Utilization in Nevada  
through Directed Research and Public Outreach**

**Great Basin Center for Geothermal Energy**

**Dr. Wendy Calvin, Director  
Formerly Lisa Shevenell**

**Great Basin Center** *for Geothermal  
Energy*

**Project Title: Expanding Geothermal  
Resource Utilization in Nevada through  
Directed Research and Public Outreach**

May 19, 2010

**Principal Investigator: Shevenell/Calvin**

**Presenter Name: James Faulds**

**Organization: Great Basin Center for  
Geothermal Energy**

Track Name: Analysis, Data System and  
Education

## Great Basin Center *for Geothermal Energy*

- Focus
  - Applied Geoscience Research
  - Conventional Hydrothermal Systems
  - Education of Students for Workforce
  - Database Development, Maintenance and Web Serving

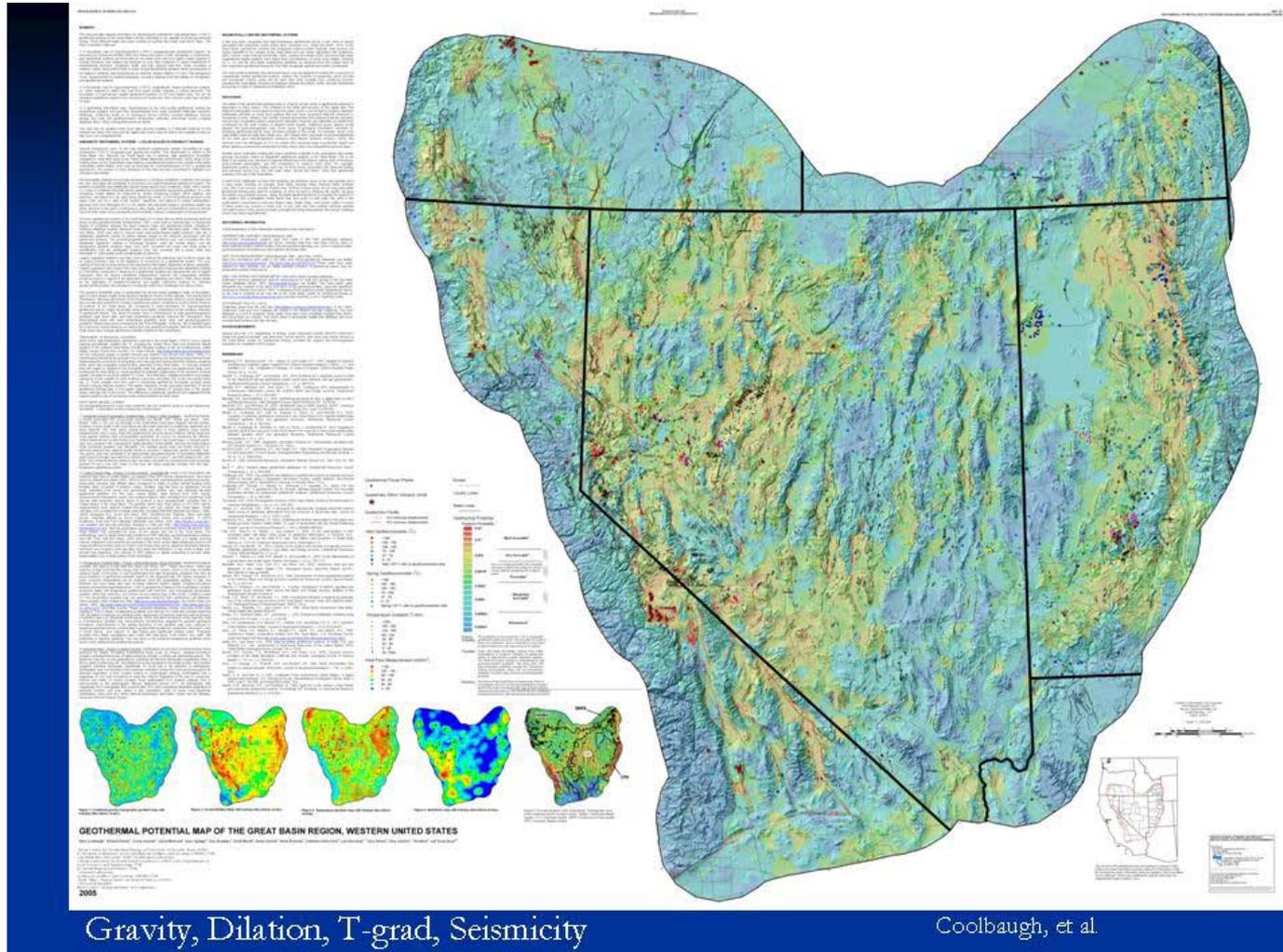
**Research:** Bell, Biasi, Blewitt, Calvin, Coolbaugh, Faulds, Garside, Hammond, Hinz, Kratt, Kreemer, Lechler, Louie, Oppliger, Plag, Ramelli, Shevenell, Sladek, Tibuleac, Zehner

- Timeline: November 5, 2009 – Dec 31, 2012
- FY09 Budget: \$682,778 DOE Share; \$125,888 Awardee Share; Project Total: \$808,666
  - Center operations and peer reviewed research projects
- FY10 Budget: \$1,000,000 DOE Share
- Barriers being addressed:
  - Site Selection & Resource Assessment
  - Site Characterization
  - Characterization of the Subsurface
- Partners:
  - Collaboration w/DOE, Industry & Navy

- This project is finding and assessing geothermal systems to
  - Increase geothermal development through research and outreach
  - Reduce risk in drill target selection, thus reducing project development costs
  - Recent research includes development of shallow temperature surveys, seismic methods, aerial photography, field structural geology.
- Located 12 new systems
  - 5 have been leased, generating \$9.1 M in BLM leasing fees
  - 2 of those currently in development for a total of 66 MW

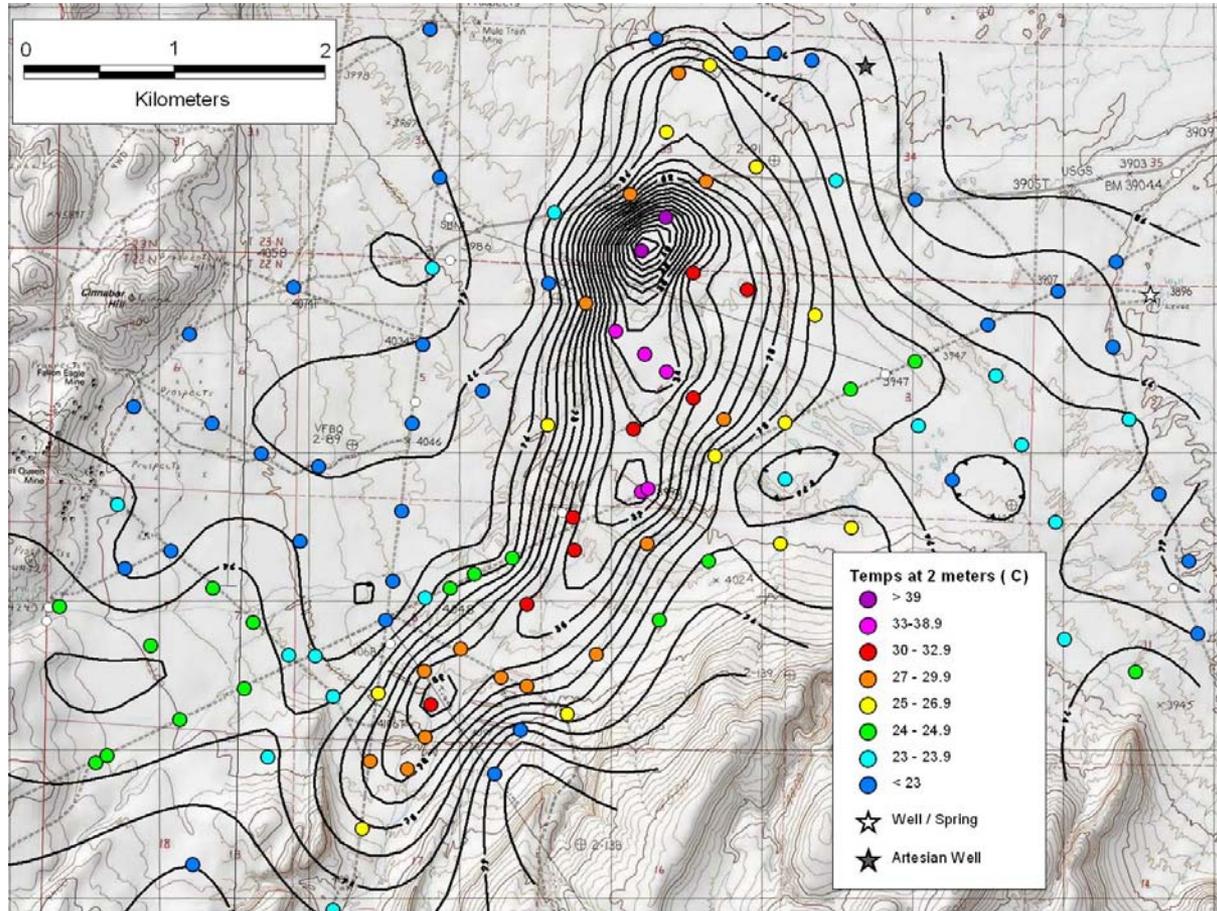
- Multidisciplinary geoscience investigations to
  - Improve understanding of the location and characteristics of geothermal systems
  - Find new geothermal systems
  - Improve exploration technologies
  - Better define the structural setting to improve drilling success
  - Construct geothermal potential maps to guide industry exploration
- Outreach components
  - Student education (grad, renewable minor, NGI (next talk))
  - Workshops
  - Databases and web site
  - Interactive maps

- Geothermal potential maps
- Undiscovered resources
- Locating blind geothermal systems
- Research to determine why Nevada is richly endowed with geothermal systems help better exploration
- Developed/refined new techniques in exploration
- ID favorable structural settings
- Bringing new systems to the attention of industry who are developing the properties



## Resource Potential Map

# Shallow Temperature Measurement



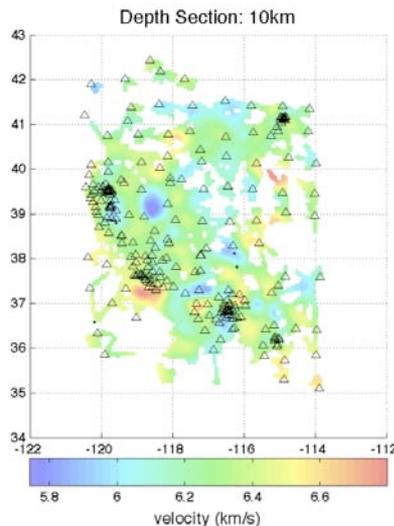
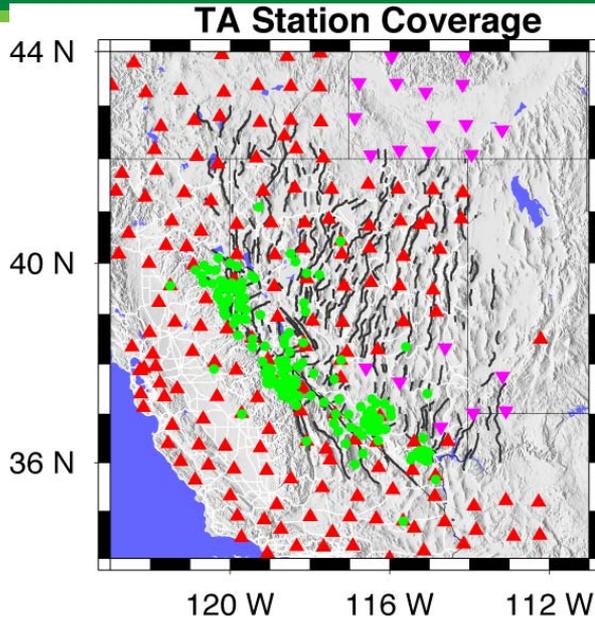
**Bottom ends of rods are welded closed &**

**hard-faced**

**Sladek,**

**Coolbaugh**

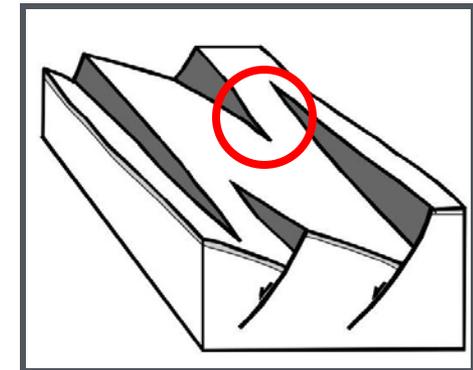
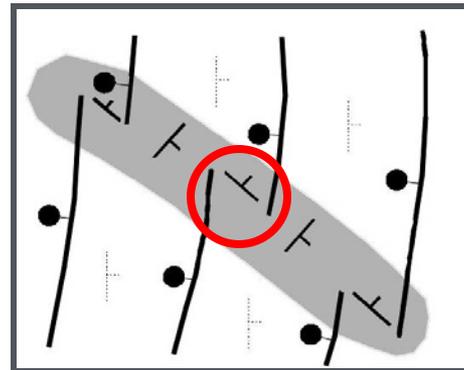
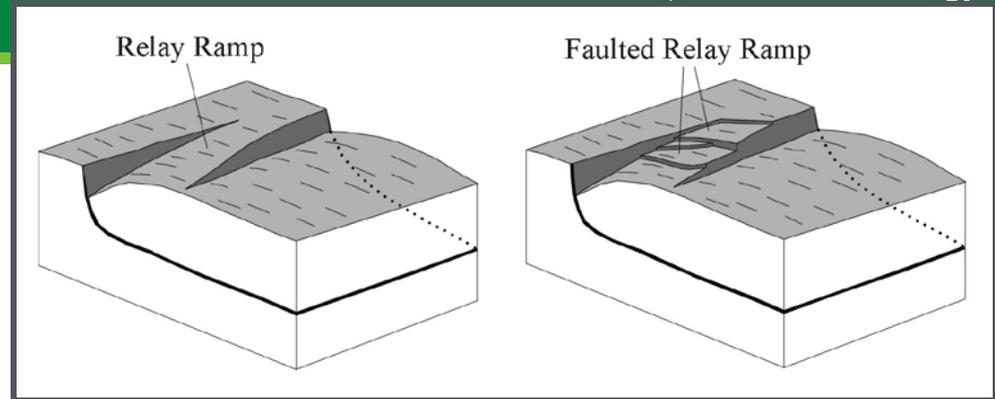
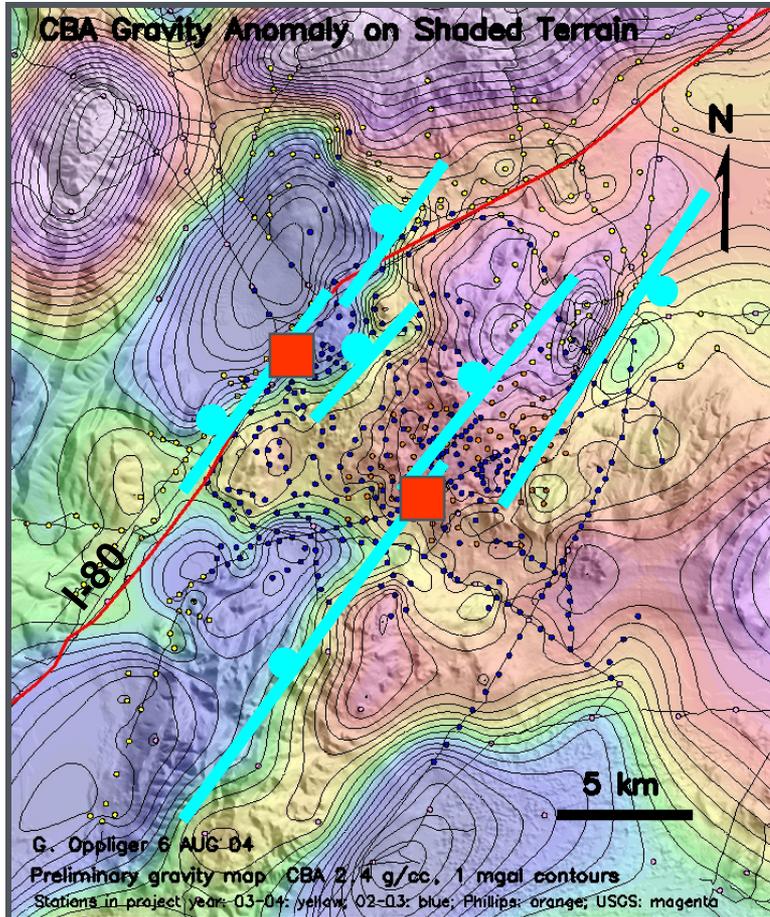
2.2 m lengths of schedule 80 seamless steel pipe  
(0.54" OD, 0.302" ID)



The temporary seismic network installed by the USArray Transportable Array (TA) in Nevada and the Great Basin provides new station coverage for regional seismic imaging.

Work applies strengths of body- and surface-wave approaches to geothermal reconnaissance and favorability.

Vp model velocities at 10 km. Some trends in velocity have surface manifestations. Extreme crustal extension seems a likely cause for the low velocities of the Carson Sink (CS). High Vp/Vs ratios usually show where fluids or extension has decreased shear-wave velocity more than compressional velocity.



- **En echelon NNE normal faults**
  - Subvertical conduits
  - High fracture density
  - Multiple step overs
- **Other favorable settings**
  - Terminations of range-front faults (Gerlach)
  - Intermeshing opposing systems (Salt Wells)

## Faults



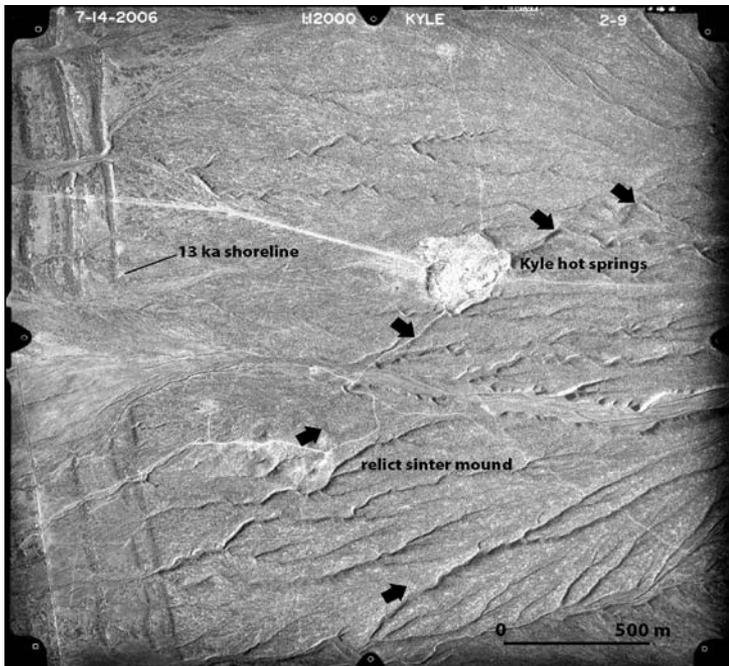
Low-sun-angle aerial photography

Large-scale (1:12,000) B&W

Early morning and late afternoon sun conditions

Sun angle 10-25°

Allows detection of small, subtle fault traces not visible on conventional mapping photography

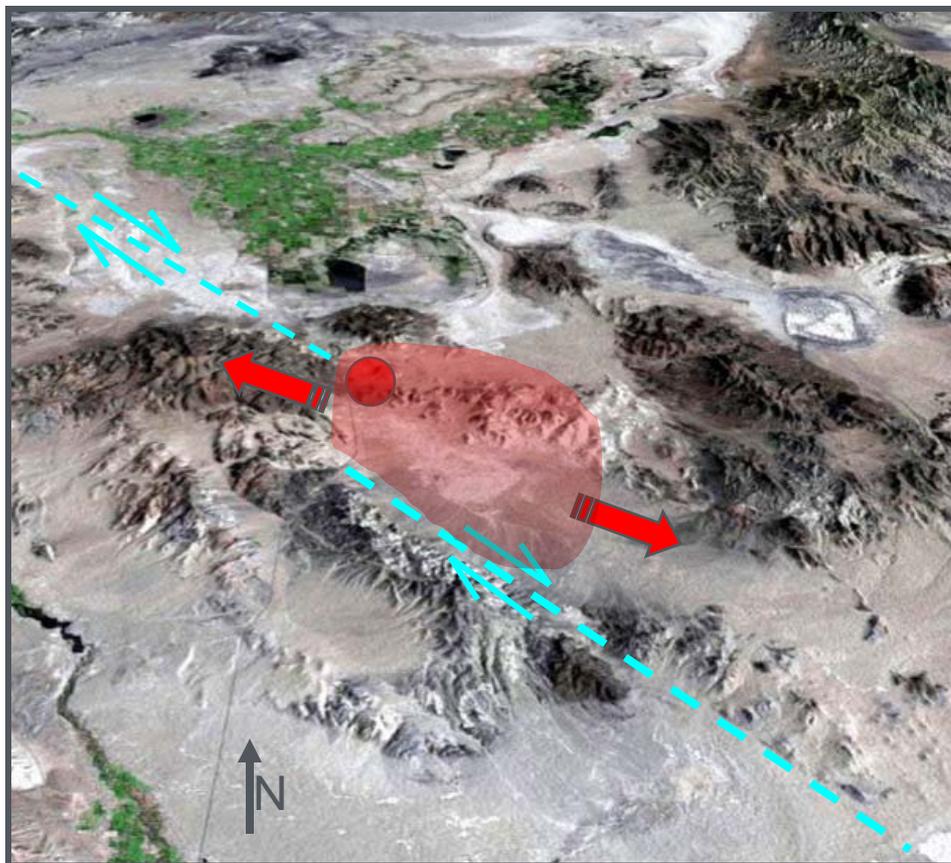


Evaluated the six sites initially found to be lacking evidence of Holocene faults, and we have found new evidence in all six areas. In particular, we targeted geothermal resource areas in the northern Pyramid Lake-Smoke Creek Desert-San Emidio Valley area, the southern Hot Springs Mountains (Patua hot springs), and the White Throne Mountain (Lee/Allen hot springs) all of which contain previously unrecognized active faults.

Bell & Ramelli

# Lee-Allen Hot Springs – Pull Apart

- Undeveloped but promising
- NW terminus of major dextral fault
- Pull-apart region
- Geothermometers – 170°C



Lee Hot Spring (96°C)

Faulds & Hinz

- Management Transition
  - GBCGE Center Director changed from Shevenell to Calvin 5/5/2010
  - Negotiation of PI transfer and grant authorization underway
- Existing work continues under established PIs
- Create a new call for directed research.
- Funded Investigators report progress and disseminate results through meetings, web site, and quarterly reports.
- RFP call and awards tied to arrival of funding.

- FY10/11 plans:
  - Conduct a peer reviewed applied research program in geothermal energy and science with studies in geological sciences, geodesy, predictive GIS modeling, remote sensing, shallow temperature surveys, and field examination of structure and groundwater and other studies of a geological nature.
  - Upgrade and maintain databases and web sites (interactive maps)
  - Collaborate on undergraduate and graduate research and education with UNR and NSHE Renewable Energy Centers.
  - Establish formal graduate program in geothermal geoscience through UNR Dept of Geological Sci & Eng.

- The Center has been successfully operating since 2002 and has been accomplishing its objectives.
- During a DOE 2005 peer review, seven of our research projects were ranked within the top eight geothermal exploration projects funded nationwide.
- We received the 2005 GRC community excellence award in geothermal work.
- We are well qualified to conduct this work, have a proven track record, and have funding and plans to advance geothermal training as it currently exists.
- We have developed a well respected position in the geothermal industry and community at large through the results of our funded research projects.

- Coolbaugh, M.F., Vikre, P.G., and Faulds, J.E., in review, Young (  $\leq 7$  Ma) gold deposits and active geothermal systems of the Great Basin: Enigmas, questions, and underdeveloped exploration potential: submitted to Geological Society of Nevada symposium.
- Coolbaugh, M.F., Vikre, P.G., and Faulds, J.E., submitted, Young (  $\leq 7$  Ma) Gold Deposits and Active Geothermal Systems of the Great Basin: Enigmas, Questions, and Underdeveloped Exploration Potential: *in* Geological Society of Nevada Symposium 2010: Great Basin Evolution and Metallogeny, Reno, Nevada, May 2010, submitted.
- Faulds, J.E., Coolbaugh, M.F., and Hinz, N.H., in review, Structural investigations of Great Basin geothermal fields: Applications and implications: submitted to Geological Society of Nevada symposium.
- Faulds, J., Moeck, I., Drakos, P., and Zemach, E., 2010, Structural assessment and 3D geological modeling of the Brady's geothermal area, Churchill County (Nevada, USA): Proceedings, Thirty-Fifth Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California, February 1-3, 2010 SGP-TR-188, 5 p.
- Faulds, J.E., Coolbaugh, M.F., Moeck, I., Oppliger, G., and Drakos, P., 2010, Structural controls of geothermal activity in the northern Hot Springs Mountains, western Nevada: The tale of three geothermal systems (Brady's, Desert Peak, and Desert Queen): submitted for Geothermal Resources Council annual meeting.
- Faulds, J.E., Coolbaugh, M.F., and Hinz, N.H., submitted, Structural investigations of Great Basin geothermal fields: *in* Geological Society of Nevada Symposium 2010: Great Basin Evolution and Metallogeny, Reno, Nevada, May 2010, submitted
- Rhodes, G.T., Faulds, J.E., and Teplo, W., 2010, Structural controls of the San Emidio Desert Geothermal Field, northwestern Nevada: submitted for Geothermal Resources Council annual meeting.