

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

Reporting Period: FY 2002 (March 20, 2002 to September 30, 2002)

DOE Grant / Contract #: DE-FG07-02ID14311

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DOE Funding Allocation: \$936 K

Cost Share Funding: \$0 K

Project Objective: The Great Basin Center for Geothermal Energy is conducting work encompassing two main tasks. We are (1) producing a web-based, stakeholder geothermal information system for Nevada geothermal data relevant to assessing and developing geothermal resources, and we are holding informational stakeholder workshops (outreach as part of GeoPowering the West (GPW) initiative), and (2) we are conducting an applied research program of peer reviewed, geothermal research addressing the goal of increasing applications of geothermal energy in the Great Basin. Approximately 10% of the granted funds will be used to accomplish the goals of task (1), another 10% will be used to provide partial administrative and management support. Approximately 80% of the granted funds are being used to fund research proposals. The objectives of both the research and outreach components of this work are to increase the amount of energy produced with geothermal resources in the Great Basin by evaluating existing, new and developing scientific methods to improve exploration and assessment of these resources.

Background / Approach: The Great Basin Center for Geothermal Energy was established at the University of Nevada, Reno in May 2000 to promote research on and utilization of geothermal resources in the Great Basin of the Western United States. The Center received funding through this grant to promote increased geothermal development in the Great Basin. Most of this funding is used to fund peer-reviewed research to improve exploration for and assessment of geothermal resources. The Center awarded seven research grants that were competitively selected with the assistance of external reviewers, and research on these projects was initiated in FY02.

Status / Accomplishments: A list of the seven research projects follows:
Geochemical characterization of magmatic-related vs. extension-related geothermal systems in the Great Basin:

Implications for exploration, exploitation, and environmental issues, \$71,128 (Greg Arehart, Mark Coolbaugh, Simon Poulson)

Targeting potential geothermal resources in the Great Basin from regional relationships between geodetic strain and geological structures \$86,917 (Geoff Blewitt)

Testing unique surface identifiers for geothermal site characterization from remote sensing imagery, \$63,733 (Wendy Calvin, Mark Coolbaugh)

Structural and geophysical analysis and characterization of the Desert Peak-Brady Geothermal Field: Implications for understanding linkages between northeast-trending structures and geothermal anomalies \$95,811 (James Faulds, Larry Garside)

Assembly of a crustal seismic velocity and density database for the western Great Basin, \$144,584 (John Louie)

Geochemical sampling of thermal and nonthermal waters in Nevada: Evaluation of geothermal resources for electrical power generation and direct-use applications - \$117,359 (Lisa Shevenell, Larry Garside)

Regional assessment of exploration potential for geothermal systems in Nevada using a Geographic Information System (GIS) - \$146,026 (James Taranik, Mark Coolbaugh, Gary Raines, Lisa Shevenell, Tim Minor, Don Sawatzky, Richard Bedell)

Work is proceeding on each of these, and preliminary results were presented for each at the annual GRC meeting in September 2002. Accomplishments on these research projects are summarized here.

- ◆ Over 50 hot spring waters in northern Nevada were sampled and analyzed in collaboration w/Shevenell. Approximately 50% of the analytical work for stable isotopes has been completed (Arehart).
- ◆ The extensional strain project has achieved the stated goal of producing and publishing (at the GRC 2002 conference) updated maps of various types of strain in the Great Basin, concluding that, on the regional scale, the extensional component of strain normal to favorably-oriented quaternary faults does well to predict the spatial trends of current geothermal power production and high well temperatures, particularly along the Humboldt lineament and in the Walker Lane; conversely, the maps therefore suggest a much lower geothermal potential toward the east-central to south-east regions of Nevada where strain rates are extremely small (Blewitt).
- ◆ Thermal infrared imagery from the SEBASS airborne scanner and the ASTER satellite scanner were used to map alteration minerals associated with geothermal activity at Steamboat Springs, Nevada and map structures along a 4-km-long thermal anomaly at Brady's Hot Springs, Nevada; these results were published in *Remote Sensing of the Environment*, a talk was given at the Denver annual GSA meeting, and a talk will be given at the annual meeting of Geological Remote Sensing Group in London in December (Calvin).
- ◆ In the Desert Peak sub-project, the major accomplishments to date include: 1) compilation of existing isothermal, well, and geologic data into a GIS data base; 2) completion of a new detailed gravity survey (323 stations covering 200 km²); 3) construction of a new Bouguer gravity map of the northern Hot Springs Mountains; and 4) enhanced understanding of the subsurface geologic framework of the Hot Springs Mountains, including depth to basement and geometry of faults (Faulds, Garside).
- ◆ A regional geophysical database supporting the exploration for new, hidden geothermal fields has been initiated with a resolution of 8 km, and supplemented by a successful deep seismic sounding experiment in May 2002 that provided the first evidence of a deep crustal root to the Sierra Nevada (Louie).
- ◆ Over 50 hot spring waters were sampled and analyzed in collaboration w/Arehart, the results of which will be used in FY03 to evaluate the geothermal potential those areas. Major and trace element analyses are nearly complete (Shevenell, Garside).
- ◆ Maps of the GPS-derived strain-rate, depth to groundwater, heat flux, and deep geothermal gradient were added to an existing geothermal GIS (of Nevada and the Great Basin) and used to predict geothermal potential in areas where geothermal activity at the surface may be suppressed because of groundwater characteristics (Taranik, Coolbaugh).

Outreach activities include database and web page development, which are continually in progress, and

workshops. Workshops that have been conducted as part of the GPW activities in FY02 include the following:

1. *Geothermal Opportunities in Nevada* involved representatives from Nevada's geothermal industry, academia, and state and federal government agencies, and was organized by the Center and held on January 11, 2002. Over 200 people attended the highly successful workshop that identified barriers to geothermal development. Presentations from the meeting can be found at <http://www.unr.edu/geothermal/>.
2. Another workshop was held January 17, 2002 at UNR to discuss and initiate Center collaboration with researchers from Lawrence Berkeley National Laboratory and Lawrence Livermore National Laboratory
3. A third workshop was held on April 18 and 19 at the Desert Research Institute in Reno, titled *Introduction to Geothermal Energy* and it was cosponsored with the Geothermal Resources Council (GRC) and the U.S. Department of Energy (DOE) GPW Program.
4. A fourth workshop, cosponsored by DOE, was held in Reno June 12-14, 2002 to highlight *DOE Sponsored Research at the Dixie Valley Geothermal Area*. Following formal presentations, working groups were assembled and a document was produced summarizing the results of research at the site. Presentations and the summary document are at: http://www.unr.edu/geothermal/meetingsandpresentations/meetings_dixie.html

Reports & Articles Published in FY 2002:

- Arehart, G., M. Coolbaugh, and S.R. Poulson. 2002. Geochemical Characterization of Geothermal Systems in the Great Basin: Implications for Exploration, Exploitation and Environmental Issues. *Transactions Geothermal Resources Council* 26: 479-482.
- Blewitt, G., M. Coolbaugh, W. Holt, C. Kreemer, J. Davis, and R. Bennett. 2002. Targeting of Potential Geothermal Resources in the Great Basin from Regional Relationships between Geodetic Strain and Geological Structures. *Transactions Geothermal Resources Council* 26: 523-526.
- Calvin, W., M. Coolbaugh, and R.G. Vaughan. 2002. Geothermal Site Characterization Using Multi- and Hyperspectral Imagery. *Transactions Geothermal Resources Council* 26: 483-484.
- Coolbaugh, M., and R. Bedell, *in press*. A Simplification of weights of evidence using a density function and fuzzy distributions: a comparison of probability modeling techniques in the designation of geothermal systems in Nevada; *Geol. Assoc. Canada Special Volume "GIS applications in the Earth Sciences."*
- Coolbaugh, M., J. Taranik, G. Raines, L. Shevenell, D. Sawatzky T. Minor, and R. Bedell. 2002. A Geothermal GIS for Nevada: Defining Regional Controls and Favorable Exploration Terrains for Extensional Geothermal Systems. *Transactions Geothermal Resources Council* 26: 485-490. (Won GRC session best paper award)
- Faulds, J., L. Garside, G. Johnson, J. Muehlberg, and G. Oppliger. 2002. Geologic Setting and Preliminary Analysis of the Desert Peak-Brady Geothermal Field, Western Nevada. *Transactions Geothermal Resources Council* 26: 491-494.
- Garside, L., L. Shevenell, J. Snow, and R. Hess. 2002. Status of Nevada Geothermal Resource Development, Spring 2002. *Transactions Geothermal Resources Council* 26: 527-532.
- Louie, J.N. 2002. Assembly of a crustal seismic velocity database for the western Great Basin. *Transactions Geothermal Resources Council* 26: 495-500.
- Skalbeck, J.D., R. Karlin, L. Shevenell, and M. Widmer, M. 2002. Geothermal reservoir volume estimation from gravity and aeromagnetic modeling of the Steamboat Hills geothermal area, Reno, Nevada. *Transactions Geothermal Resources Council* 26: 443-448.
- Shevenell, L., and J. Taranik. 2002. Overview of Activities of the Great Basin Center for Geothermal Energy. *Transactions Geothermal Resources Council* 26: 507-510.
- Shevenell, L., L. Garside, G. Arehart, M. van Soest, and B.M. Kennedy. 2002. Geochemical Sampling of Thermal and Nonthermal Waters in Nevada to Evaluate the Potential for Resource Utilization. *Transactions Geothermal Resources Council* 26: 501-506.
- Shevenell, L., and J.V. Taranik, 2002. Summary of Activities of the Great Basin Center for Geothermal Energy - *Bulletin Geothermal Resources Council* 31(5): 179-182.
- Shevenell, L., P. Kasameyer, C. Bruton, J.L. Renner, and B.M. Kennedy, 2002. Executive Summary of the

Workshop on DOE Sponsored Research at Dixie Valley, Nevada (June 12-14, 2002). Published on CD and at: http://www.unr.edu/geothermal/meetingsandpresentations/intro_summarydv.pdf

Vaughan, R.G., Calvin, W.M., and Taranik, J.V., 2002, SEBASS hyperspectral thermal infrared data: surface emissivity measurement and mineral mapping: *Remote Sensing of the Environment*, *in press*.

Presentations Made in FY 2002:

Presentations at the *Geothermal Opportunities in Nevada*, January 11, 2002, meeting:

Arehart, G. - Geochemical Techniques for Exploration and Assessment

Coolbaugh, M. - Regional Controls on the Distribution of Geothermal Systems in Nevada

Shevenell, L. - Updated Database and Assessment of Nevada Geothermal Resources

Garside, L. - Geology of Geothermal Energy, presented at the *Nevada Indian Commission's Renewable Energy Summit* for Nevada Tribes, September 10, and *Introduction to Geothermal Energy*, April 18-19, 2002.

Garside, L. - History of Nevada Geothermal Resources Research, presented at a regional GPW meeting on September 26, 2002.

Presentations at the *Annual Geothermal Resources Council Meeting*, Reno, NV, September 23-5:

Arehart, G. - Geochemical Characterization of Geothermal Systems in the Great Basin: Implications for Exploration, Exploitation and Environmental Issues.

Blewitt, G. - Targeting of Potential Geothermal Resources in the Great Basin from Regional Relationships between Geodetic Strain and Geological Structures, (poster only).

Calvin, W. - Geothermal Site Characterization Using Multi- and Hyperspectral Imagery.

Coolbaugh, M. - Geothermal GIS for Nevada: Defining Regional Controls and Favorable Exploration Terrains for Extensional Geothermal Systems.

Oppliger, G. - Geologic Setting and Preliminary Analysis of the Desert Peak-Brady Geothermal Field, Western Nevada

Garside, L. - Status of Nevada Geothermal Resource Development Spring 2002.

Louie, J.N. - Assembly of a crustal seismic velocity database for the western Great Basin (oral and poster).

Shevenell, L. - Overview of Activities of the Great Basin Center for Geothermal Energy.

Shevenell, L. - Geochemical Sampling of Thermal and Nonthermal Waters in Nevada to Evaluate the Potential for Resource Utilization.

Planned FY 2003 Milestones:

- ◆ Solicit, review and select additional research projects for funding in FY03 (Shevenell).
- ◆ Organize a workshop(s) in cooperation with DOE, based on DOE priorities (Shevenell, Taranik).
- ◆ Evaluate recently collected as well as historically available water chemistry data to determine unique characteristics of magmatic versus non-magmatic systems (Arehart).
- ◆ Construct and refine updated map using extensional strain analysis results showing favorable geothermal targets (Blewitt, Coolbaugh).
- ◆ Finalize analysis of hyperspectral data and synthesize SWIR/TIR data at Steamboat Hills (Calvin).
- ◆ Construct a new geologic map and gravity survey in GIS format of the Desert Peak, Hot Springs Mountains geothermal area, and construct a 3-D subsurface model in digital format (Faults, Garside).
- ◆ Collect industry feedback on web interface to seismic database, and make final changes to web database, delivering a copy of the database on CD/DVD to DOE (Louie).
- ◆ Complete sampling and analysis of the first phase of hot springs selected for evaluation; calculate and evaluate geothermometers (Shevenell, Garside).
- ◆ Prepare predictive maps of geothermal potential in using multiple GIS layers (Taranik, Coolbaugh).
- ◆ Technical papers and reports will continue to be prepared as part of all of the subprojects.