Nevada Renewable Energy Consortium Meeting

Aug 20th, 9:45 AM - 10:10 AM

Great Basin Center for Geothermal Energy

Wendy Calvin
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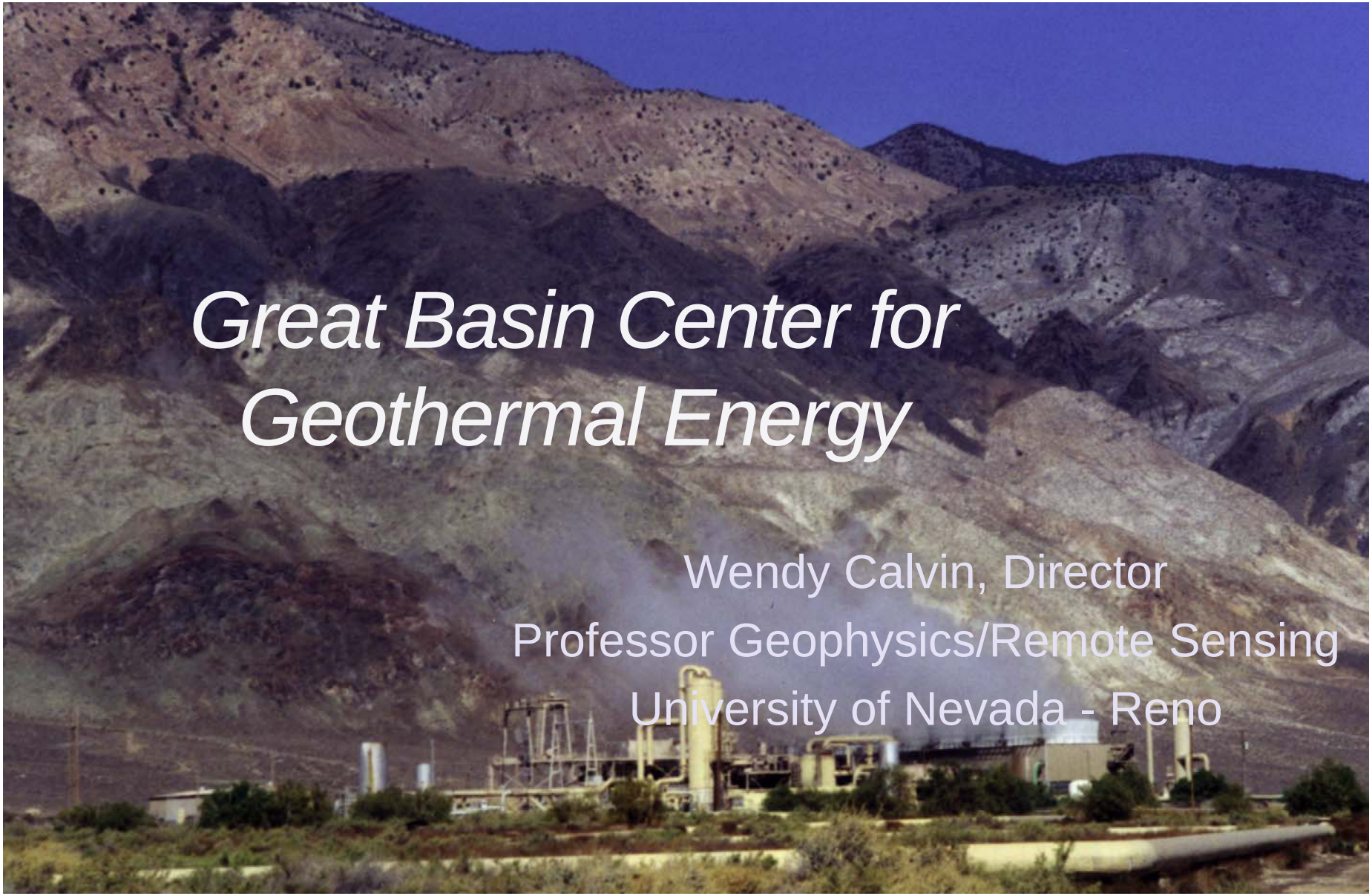


Great Basin Center for Geothermal Energy

Wendy Calvin, Director
Professor Geophysics/Remote Sensing
University of Nevada - Reno

For Nevada Renewable Energy Consortium, 20.aug.10

History / Support

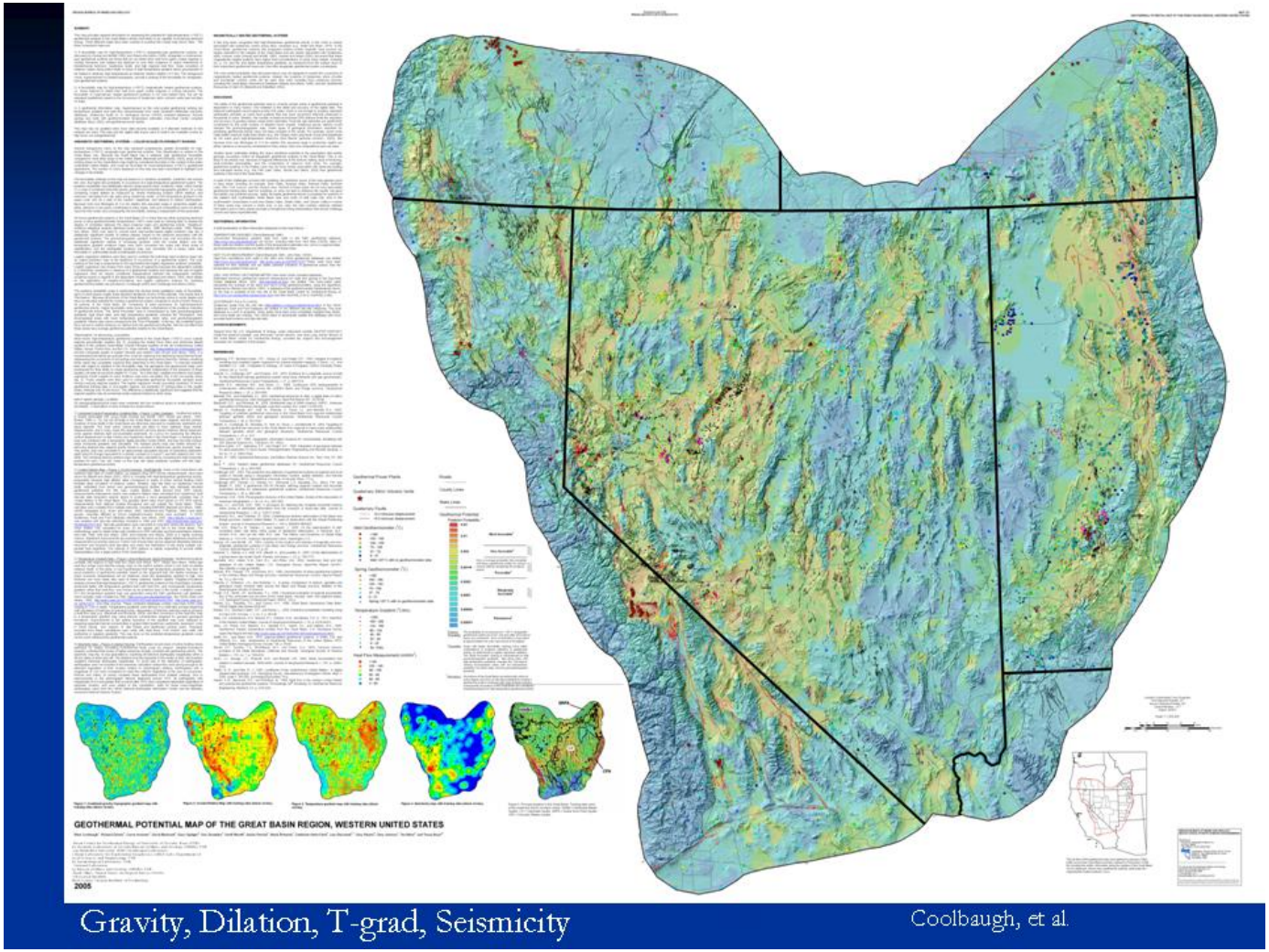
- Established in Fall 2002
- Center funding to date ~ $14M in US Govt and private sources.
- DOE ARRA Awards (structure, seismology, fracture modeling)
- National Geothermal Academy
- National Geothermal Database

www.unr.edu/geothermal

Research Strengths

- Structural Geology
- Seismology
- Geophysics (gravity/mag)
- Geodesy
- Remote Sensing/GIS
- Geochemistry
- Engineering: Chemical, Mechanical, Mining

Past Accomplishments



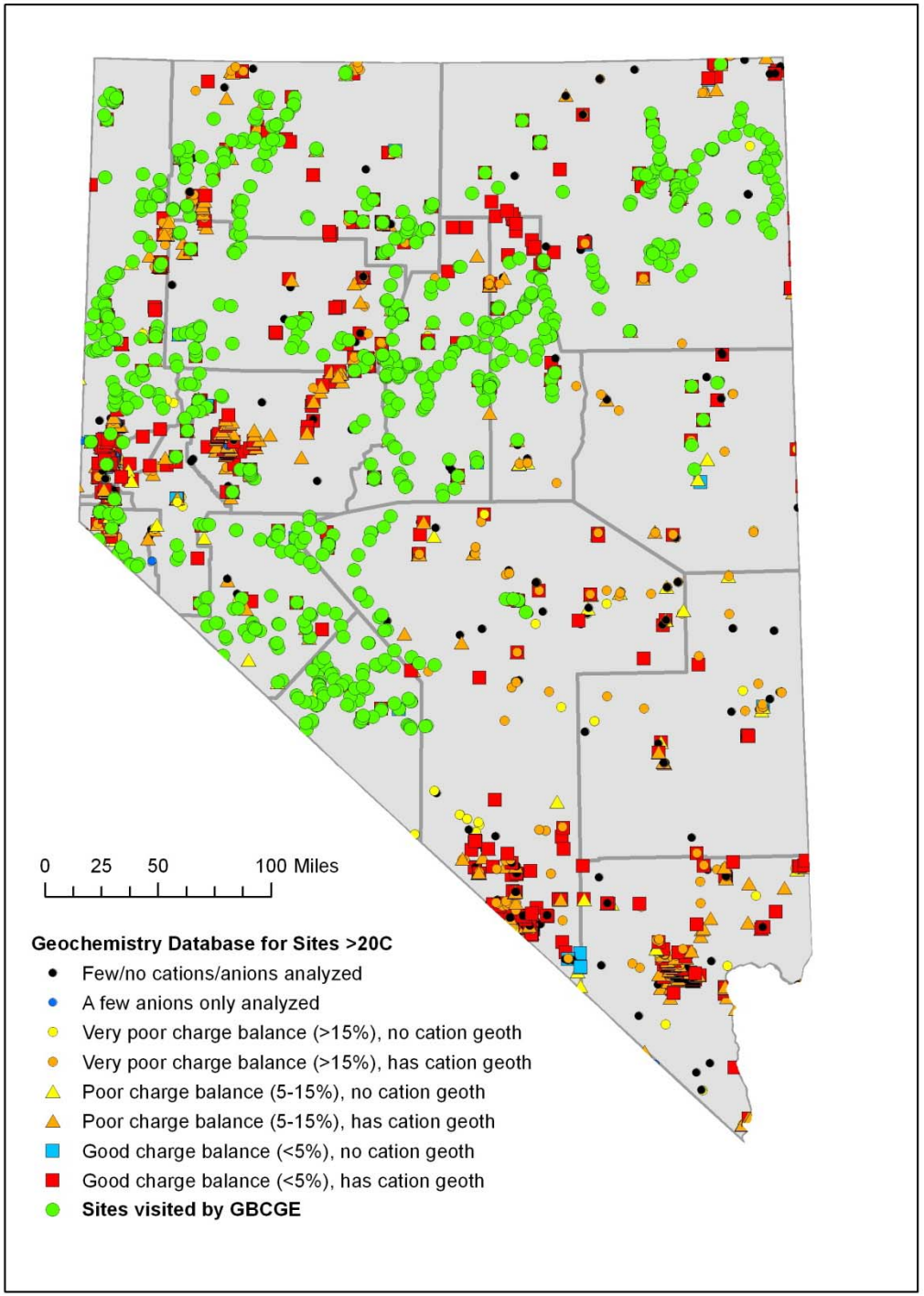
Resource Potential Map

Geochemical sampling by GBCGE, overlying map of historical water analyses:

- Quality of charge balance for historical geochemistry is indicated in legend.

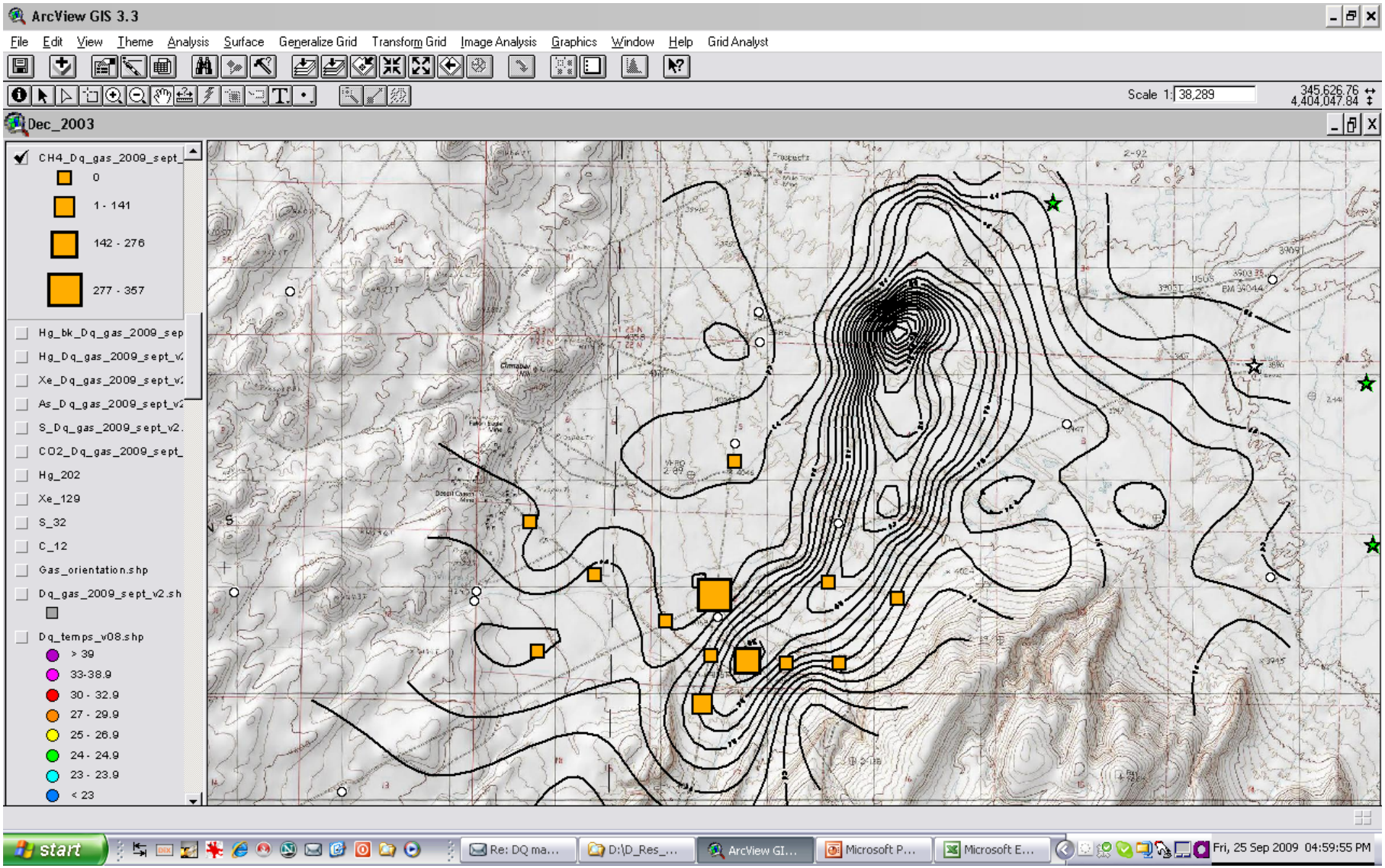
- As of July 2010, there are 120 reported thermal sites with poor charge balance and/or inadequate temperature data.

- GBCGE sample coverage included 1060 site visits (for temperature and location confirmation) and 322 geochemical analyses.



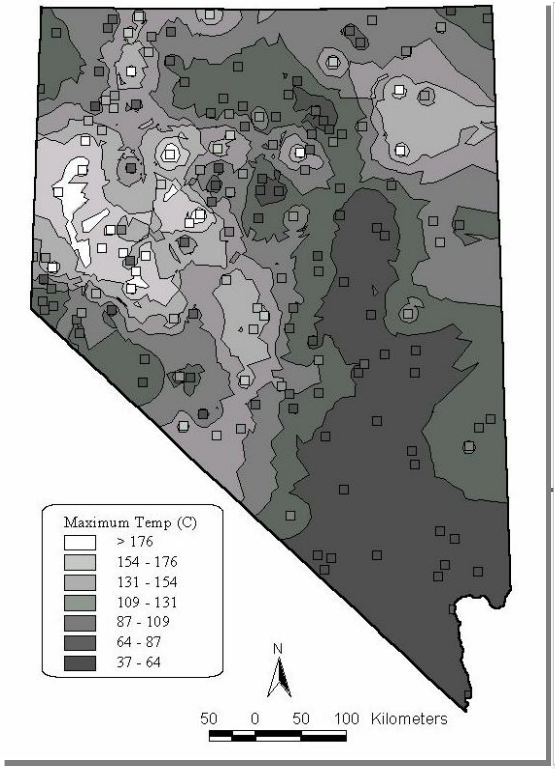
Shevenell

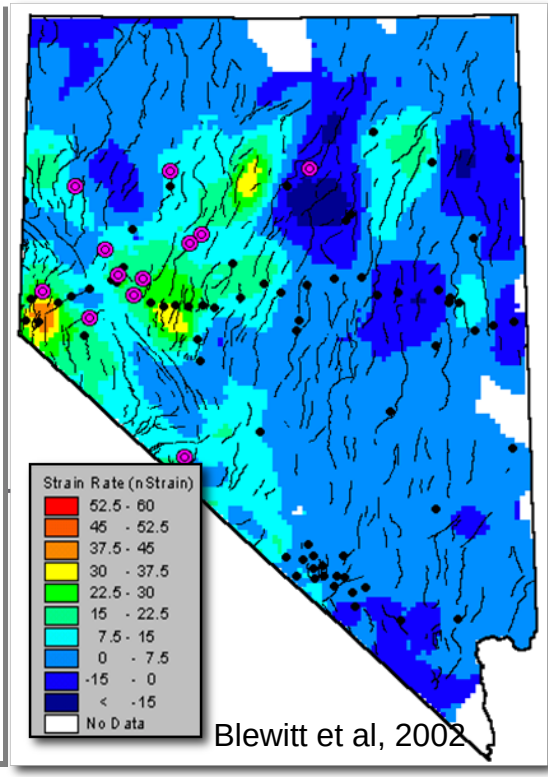
Soil Gasses: Methane (CH_4)



Lechler

Geodesy Measures Crustal Strain Rates, Fault Slip Rates and Potential for Geothermal Resources

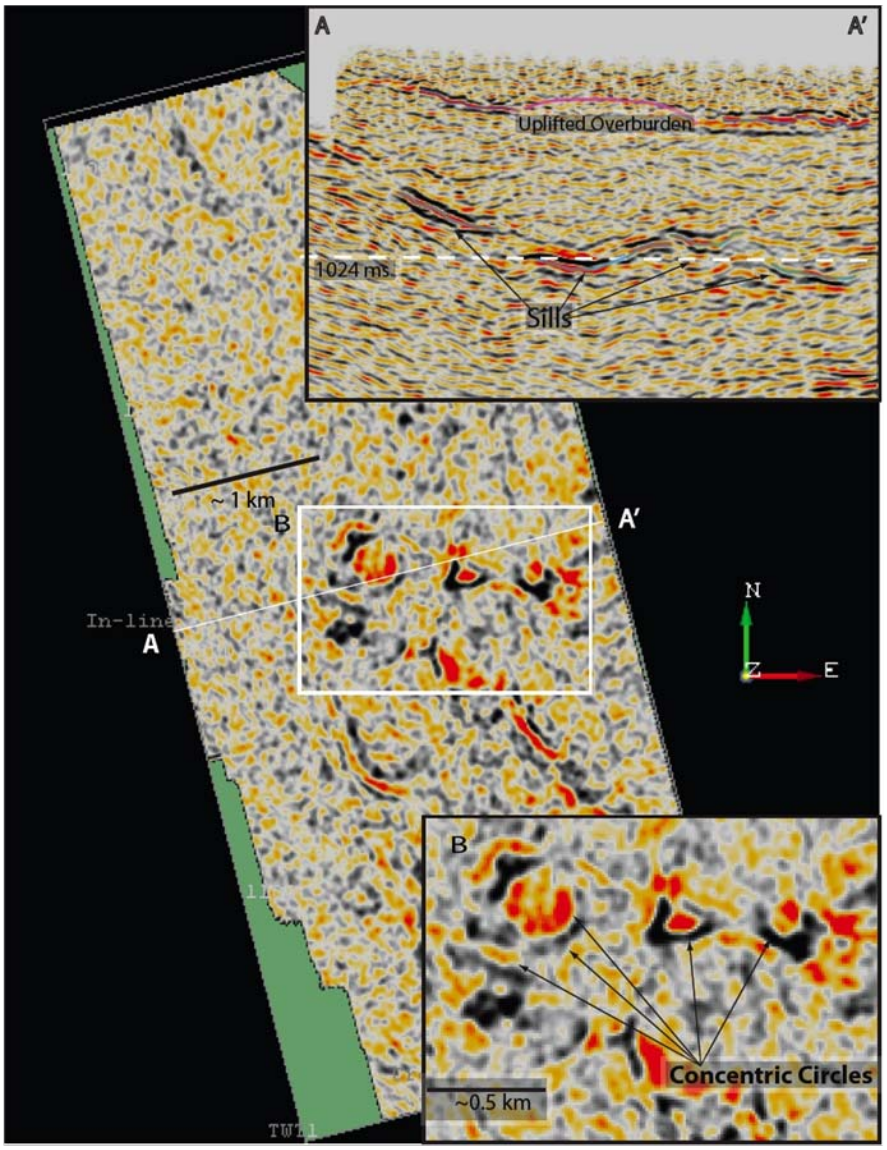




Blewitt et al, 2002

Blewitt/Hammond

Seismic Imaging – J. Louie

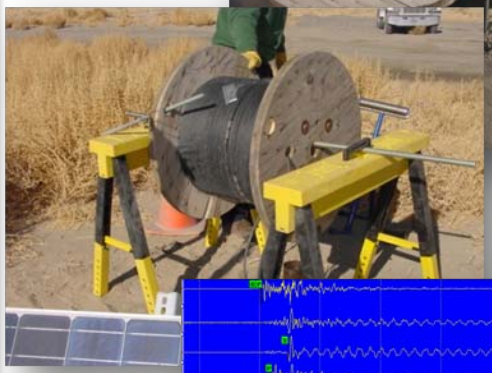


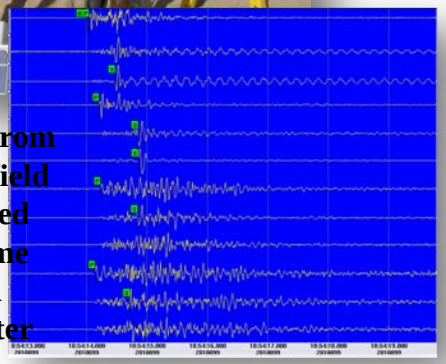
- ‘01-’07: Established long-range refraction facility, surveyed W. Basin & Range crust with mine blasts. Developed Community Modeling Environment.
- ‘09-’10: Interpretation of 3D seismic volume at geothermal prospect (left); unexpected sill hypothesis.
- ‘10-’13: Imaging for DOE-ARRA projects with Optim at:
  - Pyramid Lake Paiute Reservation
  - Rye Patch advanced VSP
  - San Emidio 9-component seismic
  - Hot Pot full-wave inversion
  - Soda Lake 3D-3C survey

Nevada Seismological Laboratory

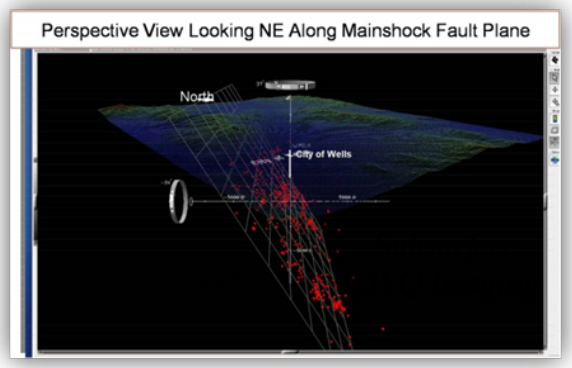
Complete micro-earthquake (MEQ) monitoring capability
Remote real-time communications to Reno data center
Modern high-precision event location techniques
Full seismic waveform applications for structure/earthquake source
Currently operating real-time MEQ monitoring networks in NV

Real-Time Telemetered Borehole Seismic Networks



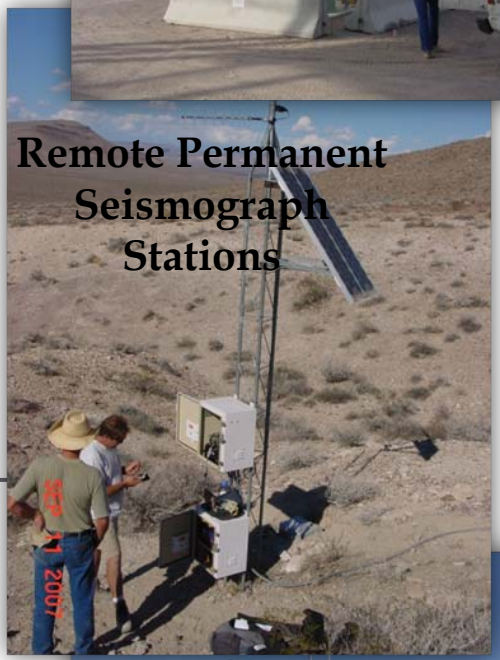


MEQ data from producing field transmitted in real-time to UNR Data Center



Smith

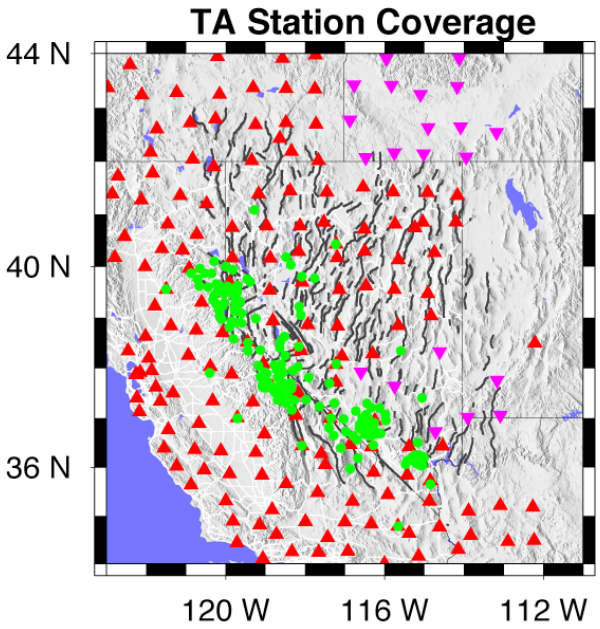
Deep Borehole Systems



Remote Permanent Seismograph Stations

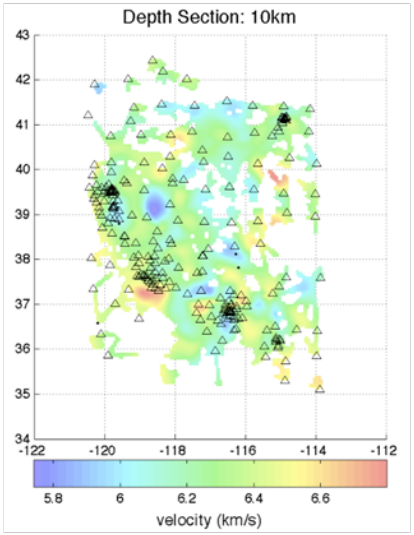
NSL Statewide Telemetry System

Seismic Networks



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.

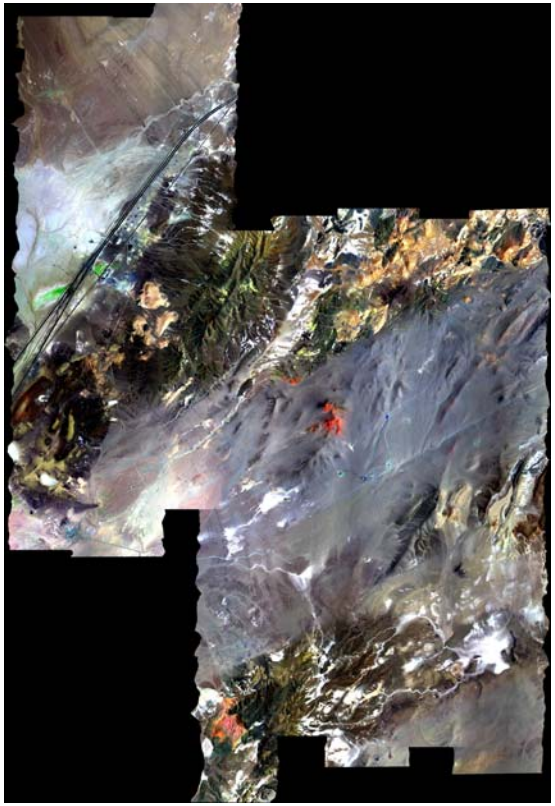
Work applies strengths of body- and surface-wave approaches to geothermal reconnaissance and favorability.

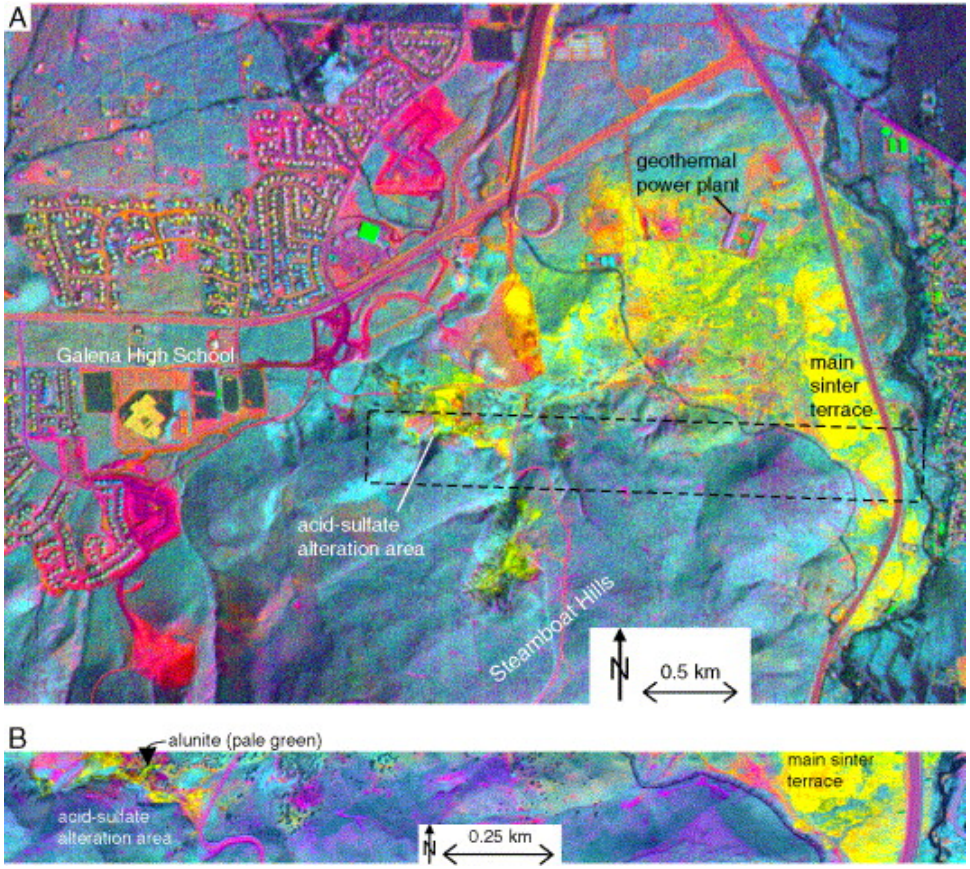


Vp model velocities at 10 km. Some trends in velocity have surface manifestations. Extreme crustal extension seems a likely cause for the low velocities of the Carson Sink (CS). High Vp/Vs ratios usually show where fluids or extension has decreased shear-wave velocity more than compressional velocity.

Biasi

Remote Sensing/Mineralogy





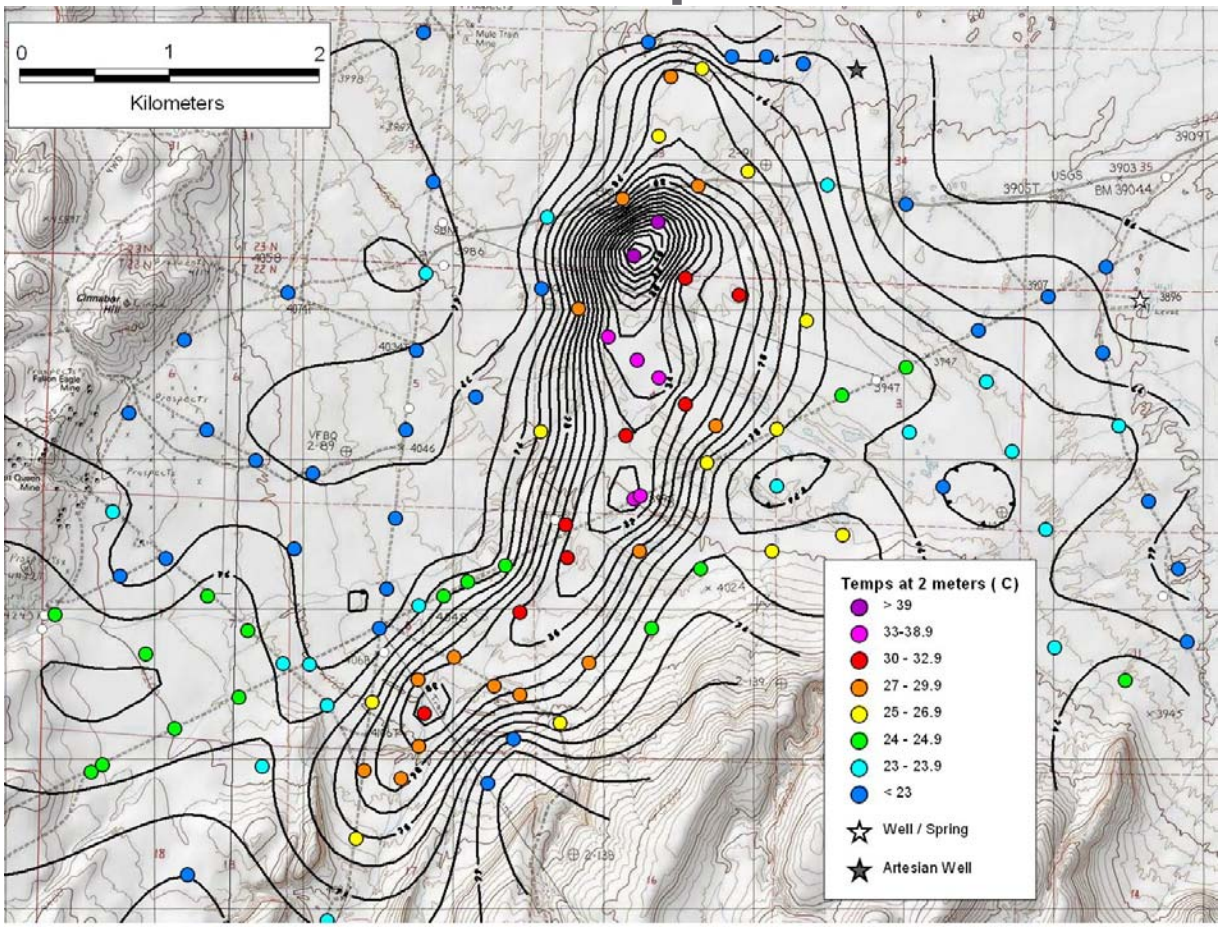
Calvin, Kratt

Satellite and Aircraft, Multi- Hyperspectral, SWIR and TIR.

Mineralogy, thermal anomalies, surface alteration, well alteration.

Steamboat, Brady's, Pyramid Lake, Fish Lake Valley, Dixie Valley

Shallow Temperature Measurement

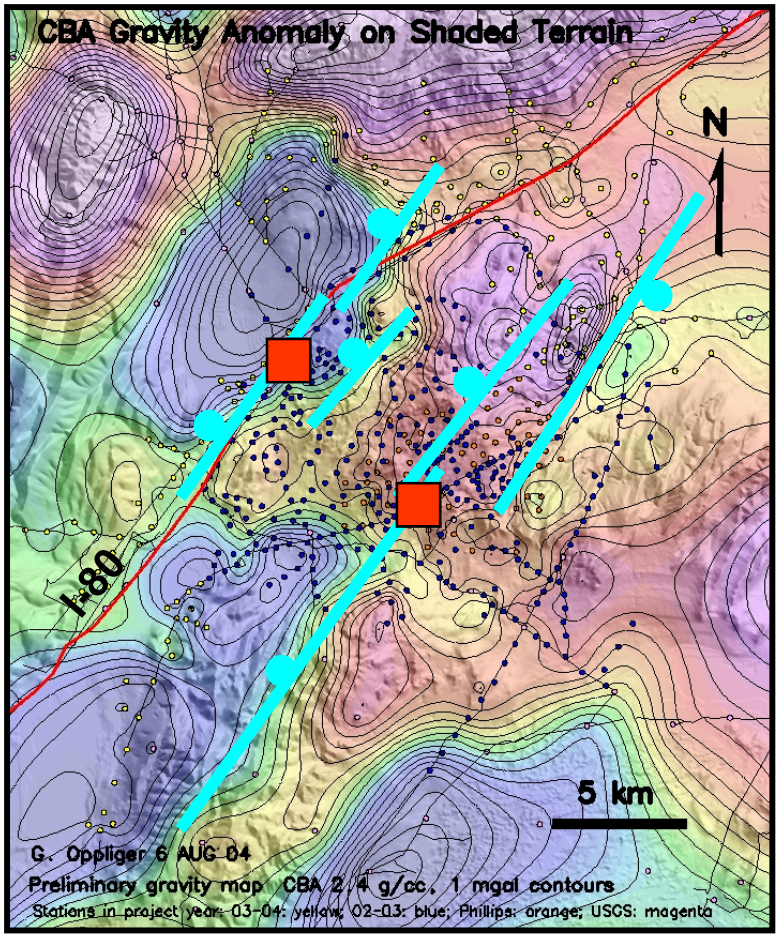


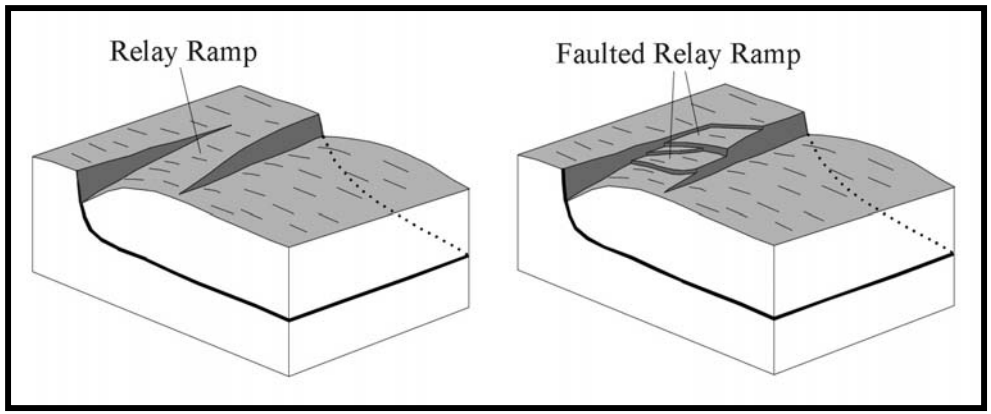
Bottom ends of rods are welded closed & hard-faced

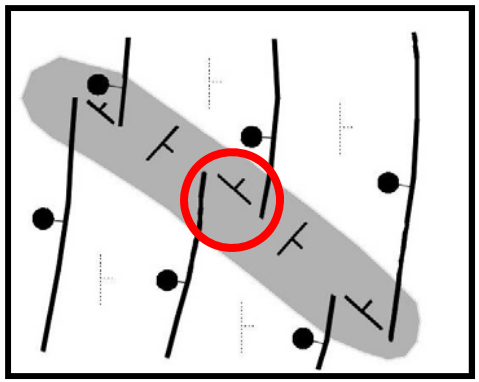
Sladek, Coolbaugh

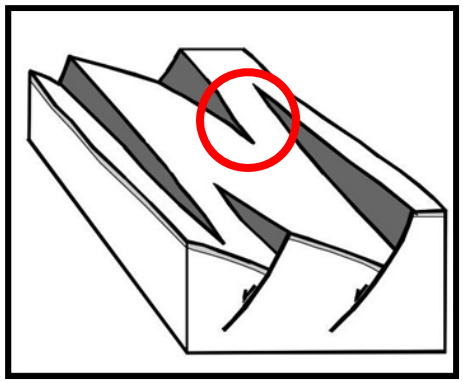
2.2 m lengths of schedule 80 seamless steel pipe (0.54” OD, 0.302” ID)

Favorable Structural Settings









- **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)**

Faulds

Active Fault Controls

Low-sun-angle aerial photography

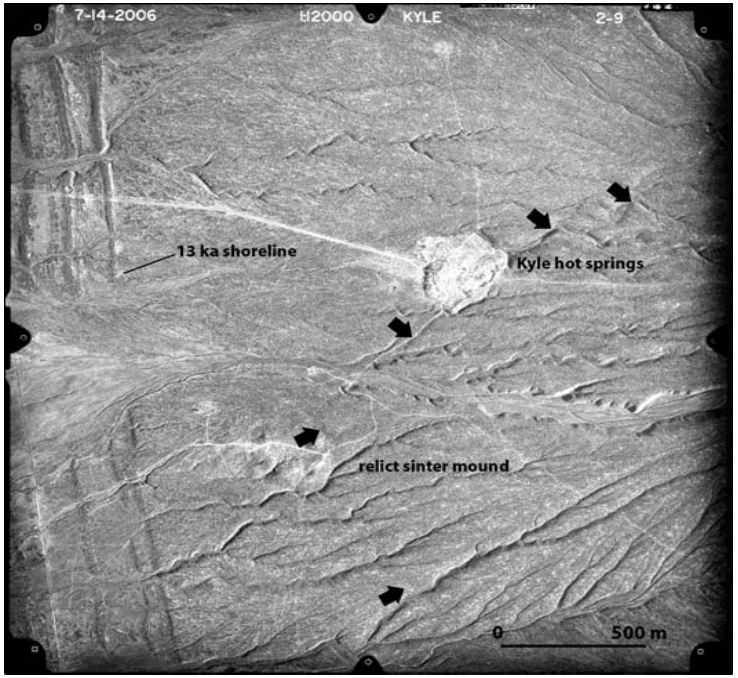
Large-scale (1:12,000) B&W

Early morning and late afternoon sun conditions

Sun angle 10-25^{o}

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

Expanding to use LiDAR



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

Education

University of Nevada – Reno

- Undergraduate Renewable Energy Minor
- Proposed Graduate Renewable Energy Certificate
- Geothermal MS/PhD Program in Geosciences
- National Geothermal Academy
  - In development for Summer 2011
  - Undergraduate and Graduate accredited course
  - Graduate Certificate in Geothermal
  - Summer field projects / design competition
  - Plant operations and training
  - Professional development

Past Thesis/Dissertations

5 PhDs, 16 MS Degrees

- Structural Geology (4 MS)
- Seismology (4 PhD, 3 MS)
- Geodesy (1 MS)
- Hydrology (3 MS)
- Geochemistry (2 MS)
- Remote Sensing/GIS (1 PhD, 1 MS)
- Geophysics (2 MS)

Current Students: 3 MS, 2 ChemE, 4 new geosci. this fall

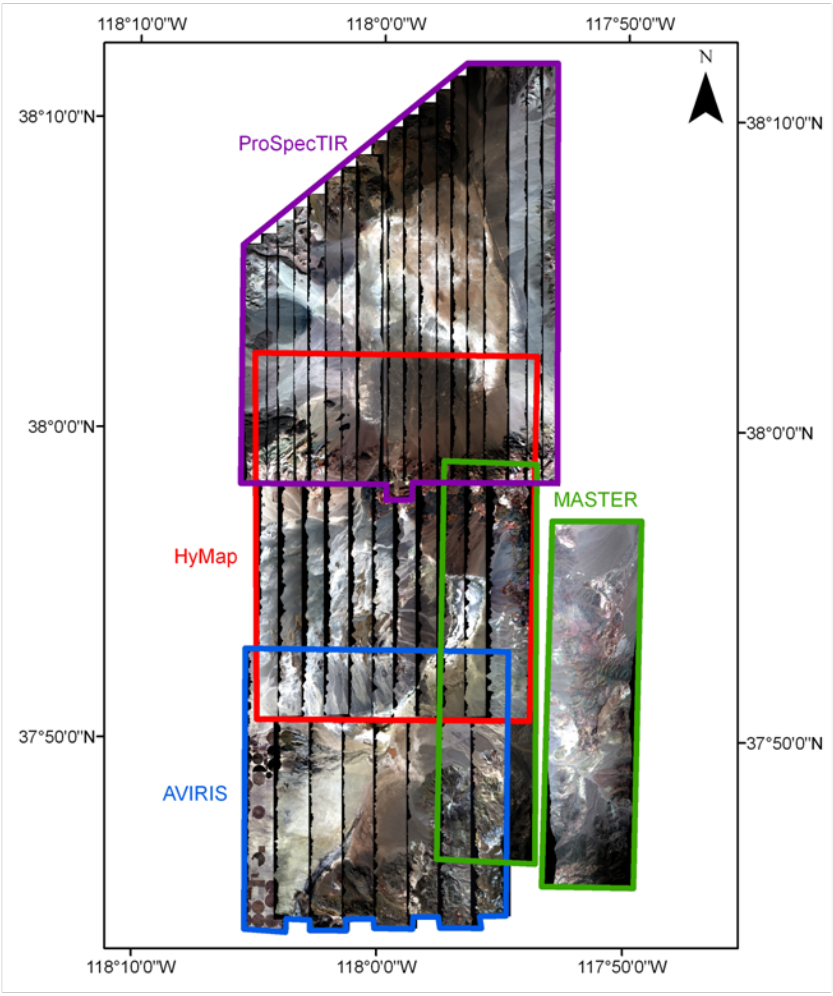
Undergraduate: New NSF E-Scholars

Energy Engineering (Chem E or EE, or Renew. Minor)

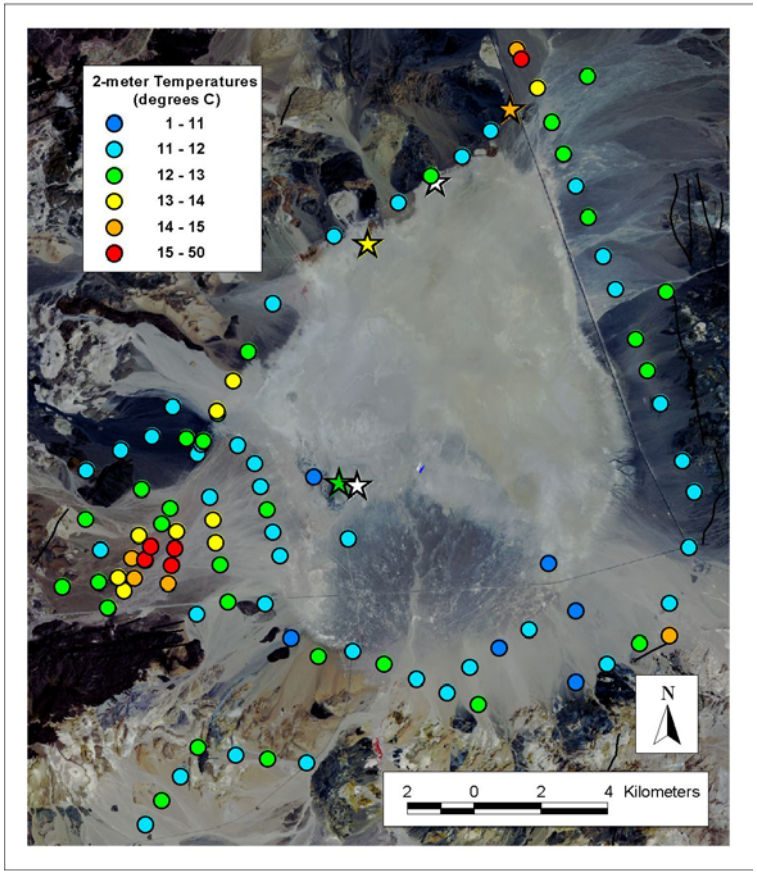
Relationship to NVREC Projects

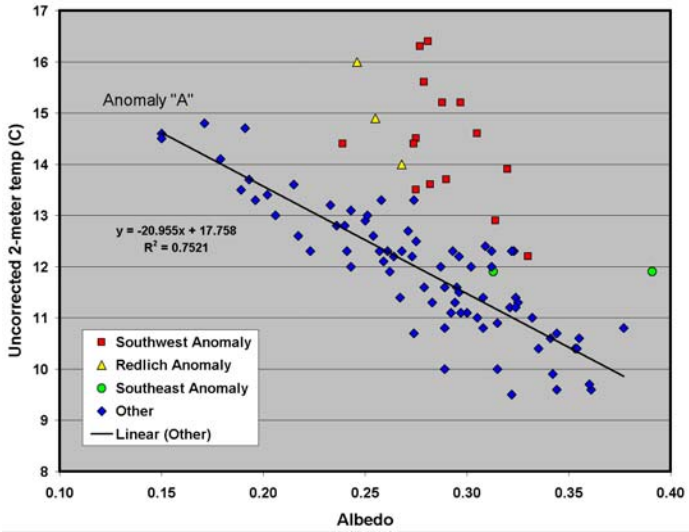
- Task 3.0 Geothermal Prospecting
- Two tasks – Extensions of former work
  - 3.1 Kratt (DRI) Hyperspectral Remote Sensing
    - Analysis of comprehensive SWIR and TIR data sets over Columbus Marsh
  - 3.2 Coolbaugh (UNR) Shallow –T and soil gas surveys
    - Primarily equipment upgrades and purchases
- Two tasks – new efforts
  - 3.3 Adams (DRI) Regional Heat Flow and Isostatic Rebound
    - Determine correlation of anomalous rebound and high heat flow
  - 3.4 Vasquez (UNR) Life cycle analysis
    - Explore case study for policy, technology and economic changes
- Strongly Encourage you to visit respective posters!

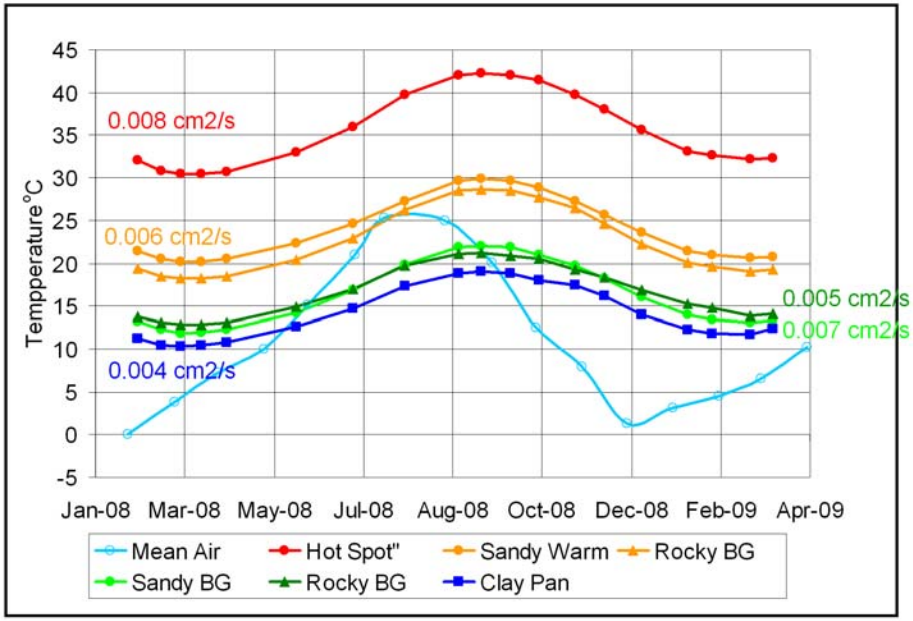
Hyperspectral Remote Sensing



Shallow Temperature







Method development includes correction for albedo correlation and seasonal temperature effects.

Isostatic Rebound

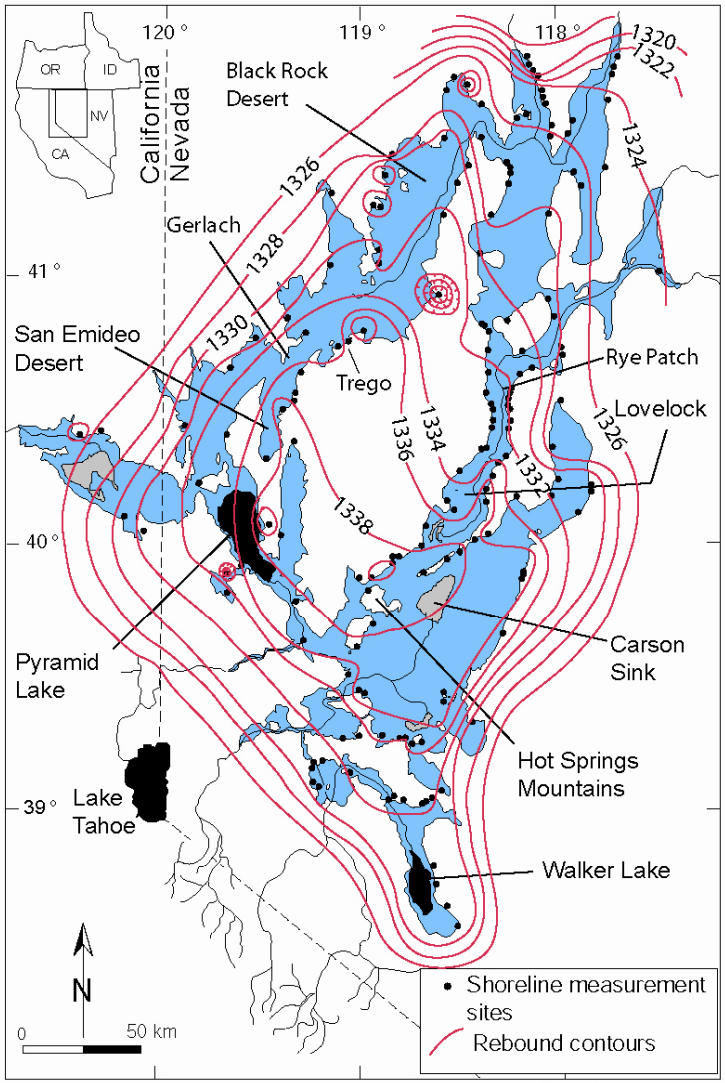


Figure 1. Map showing the character and magnitude of isostatic rebound recorded by the high shoreline after desiccation of Lake Lahontan. Also shown are present day rivers and lakes and locations of places mentioned in text. Contour interval is 2 m. After Adams et al. (1999).

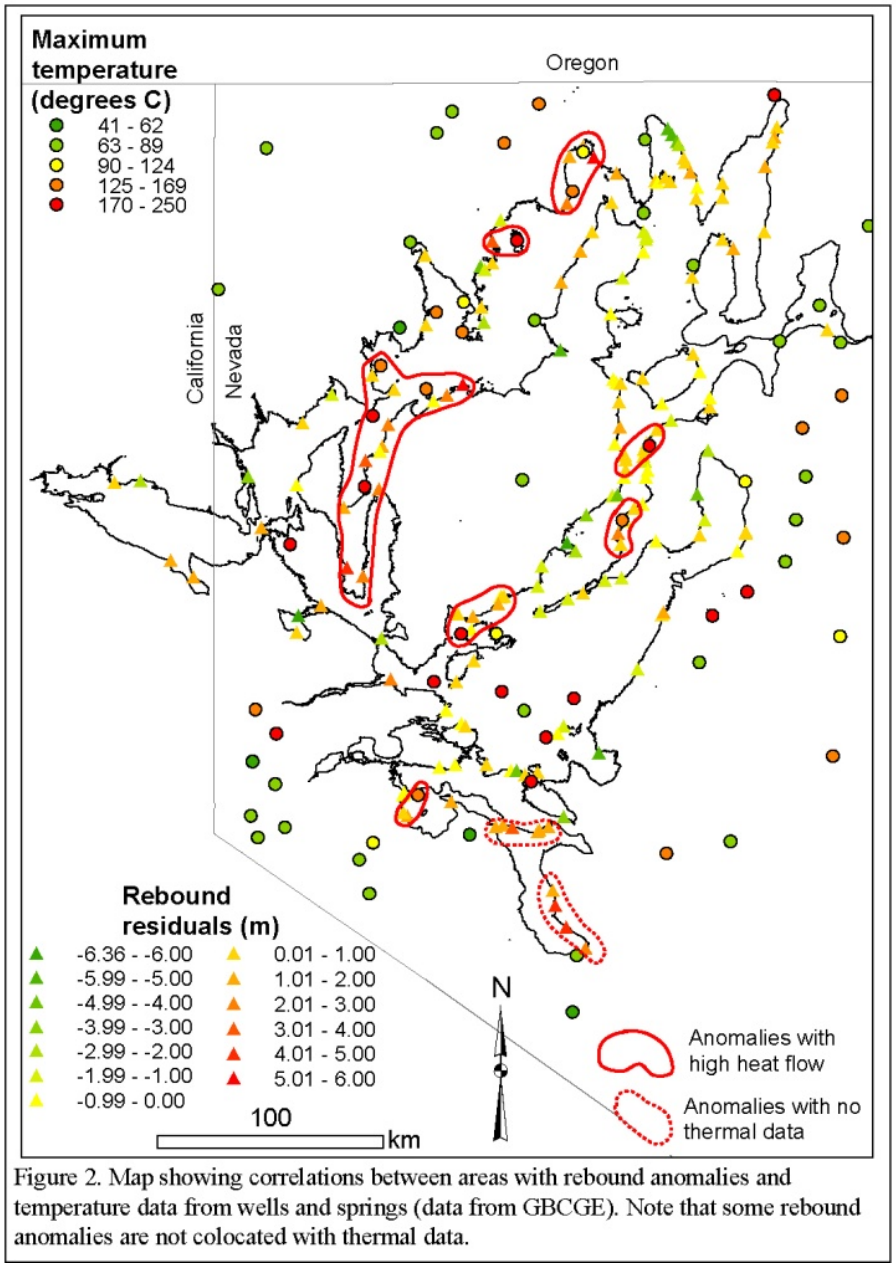


Figure 2. Map showing correlations between areas with rebound anomalies and temperature data from wells and springs (data from GBCGE). Note that some rebound anomalies are not colocated with thermal data.

Life Cycle Analysis

- Design and develop static and dynamic Life Cycle Analysis (LCA) scenarios and methods for sustainable development of geothermal energy extraction and exploration projects in Northern Nevada.
- Evaluate and demonstrate the LCA framework with case studies of interest for the region, and possibly extend these to other renewable energy related activities in the region.
- The scope and system boundaries for life cycle analysis of geothermal power production in the region is divided into three independent subsystems:
  - Exploration of potential hydrothermal reservoir
  - Drilling activity and geothermal power production
  - Post-use re-cultivation
- For each of these subsystems ISO 14040 and 14044 standards are applied including scope of study, collection of data and allocation for life cycle inventory analysis, LCA impact assessment and interpretation.