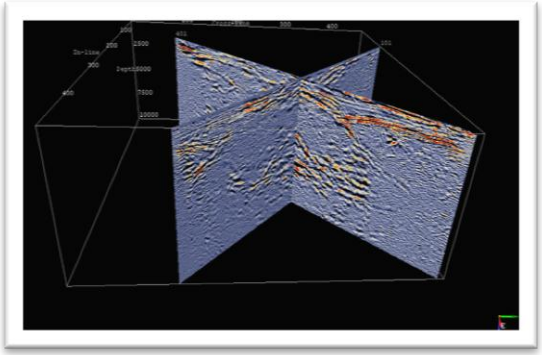


Advanced Seismic Data Analysis Program – The "Hot Pot" Project

Project Officer: Ava Coy

Total Project Funding: $8,199,656.00

April 23, 2013

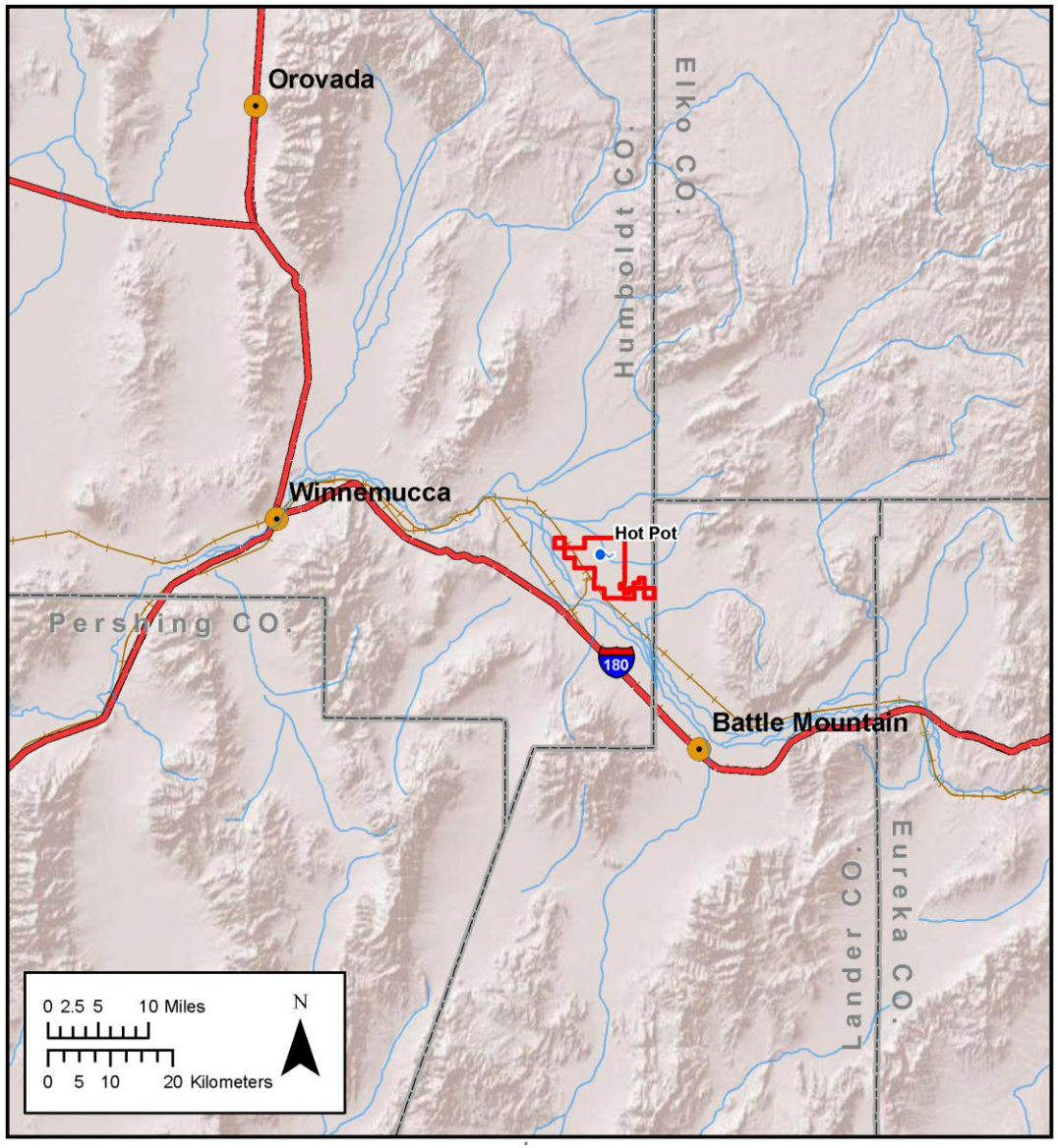
Principal Investigator : Frank Misseldine

Presenter: Mike Lane

Organization: Oski Energy, LLC

Track 1 – Innovative Exploration Technologies

Project Location

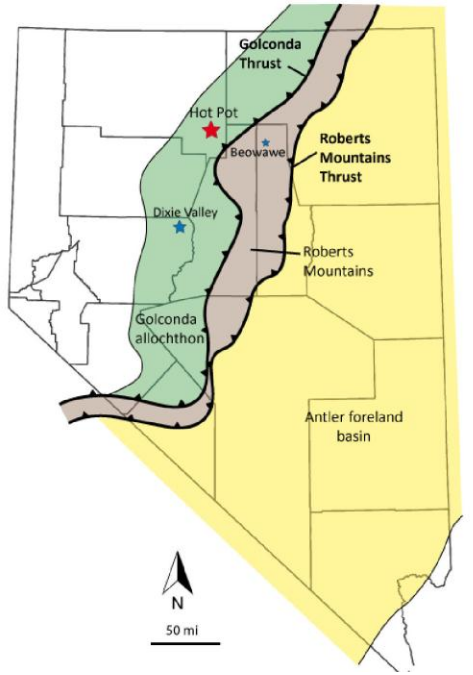


Hot Pot
Humboldt County, NV

Legend

- Project area
- Hot Pot springs
- Rivers
- Highway

Regional Paleozoic Structural elements



Relevance/Impact of Research

Project Objective: To improve the quality and quantity of plausible drilling targets as early as possible within the exploration process, rather than as a result of unsuccessful development wells.

***Become smarter, sooner*.**

- Challenges, barriers, knowledge gaps, or problems
  - Reflection seismic is widely utilized in the oil and gas industry, but traditionally has not been effective in geothermal areas due to complex geologic structure and poor velocity contrast.

- Impact on costs of geothermal energy development.
  - Exploration wells, *or even intermediate temperature gradient holes*, that are targeted to test specific structures or the project conceptual model, can reduce drilling risk, (reduce number of unsuccessful wells), shorten project development timelines, and reduce costs.

Relevance/Impact of Research (2)

- Innovative aspects
  - Seismic data processing generally follows procedure discussed by Honjas, Pullammanappillil, et. al. (GRC Transactions v 26, 45-52). Main objective of processing is to develop a 3D velocity volume, through which reflectors are migrated to correct location.
  - Maximum use of existing direct & indirect subsurface data.
  - Extensive data reprocessing guided by highly experienced project team.
- How will success within this project impact GTP goals?
  - Validation of active source reflection seismic to define drilling targets in complex geologic environments can lower exploration risk and reduce development cost.

Scientific/Technical Approach

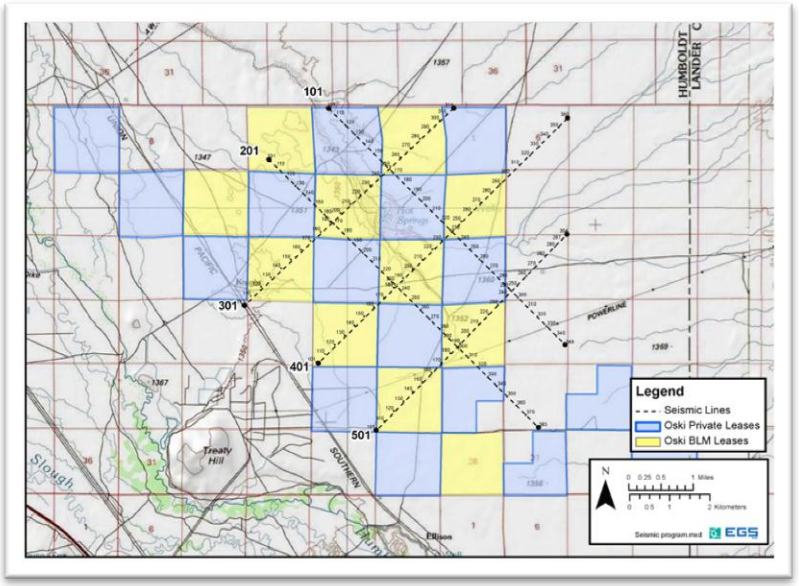
- Project Design
  - Obtain all possible relevant background information
  - Address major data gaps (detailed gravity, shallow temp. gradient)
  - Lay out seismic lines to:
    - Image most probable fault orientations
    - Fully utilize advanced processing capability (orthogonal grid, consistent line spacing)
    - Extend (with appropriate permits) beyond target area in order to identify background conditions
  - Set data acquisition and processing parameters based on contractor's experience with similar projects
  - Establish frequent project meetings with key project personnel, especially during critical data processing & interpretation times

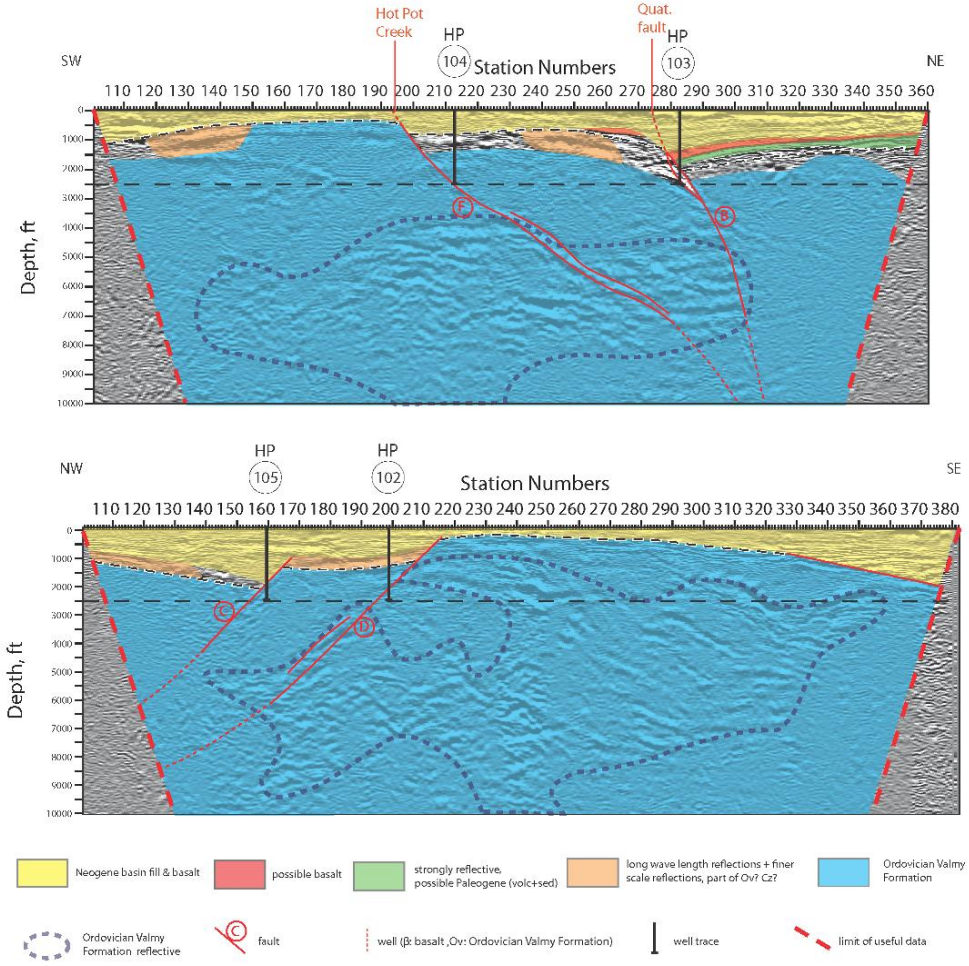
Scientific/Technical Approach (2)

- Data Interpretation
  - Guided by knowledge of regional and most probable site-specific geologic environment
  - Refined as seismic images improved due to velocity model adjustment

- Key Issues (problem, solution, significance)
  - Initial seismic images contained large areas of poor data
  - Some shallow high velocity zones were identified from mineral exploration well control
  - Velocity model was adjusted, lines reprocessed, and interpretable data obtained, even in Paleozoic basement to depth of ~ 5,000’
  - Seismic images suggest major low-angle structures in Paleozoic which could be pathways for geothermal system fluids

Scientific/Technical Approach (3)





Line Layout

- Grid
- Orientation
- Off-Lease

Stratigraphy

Neogene Sediments

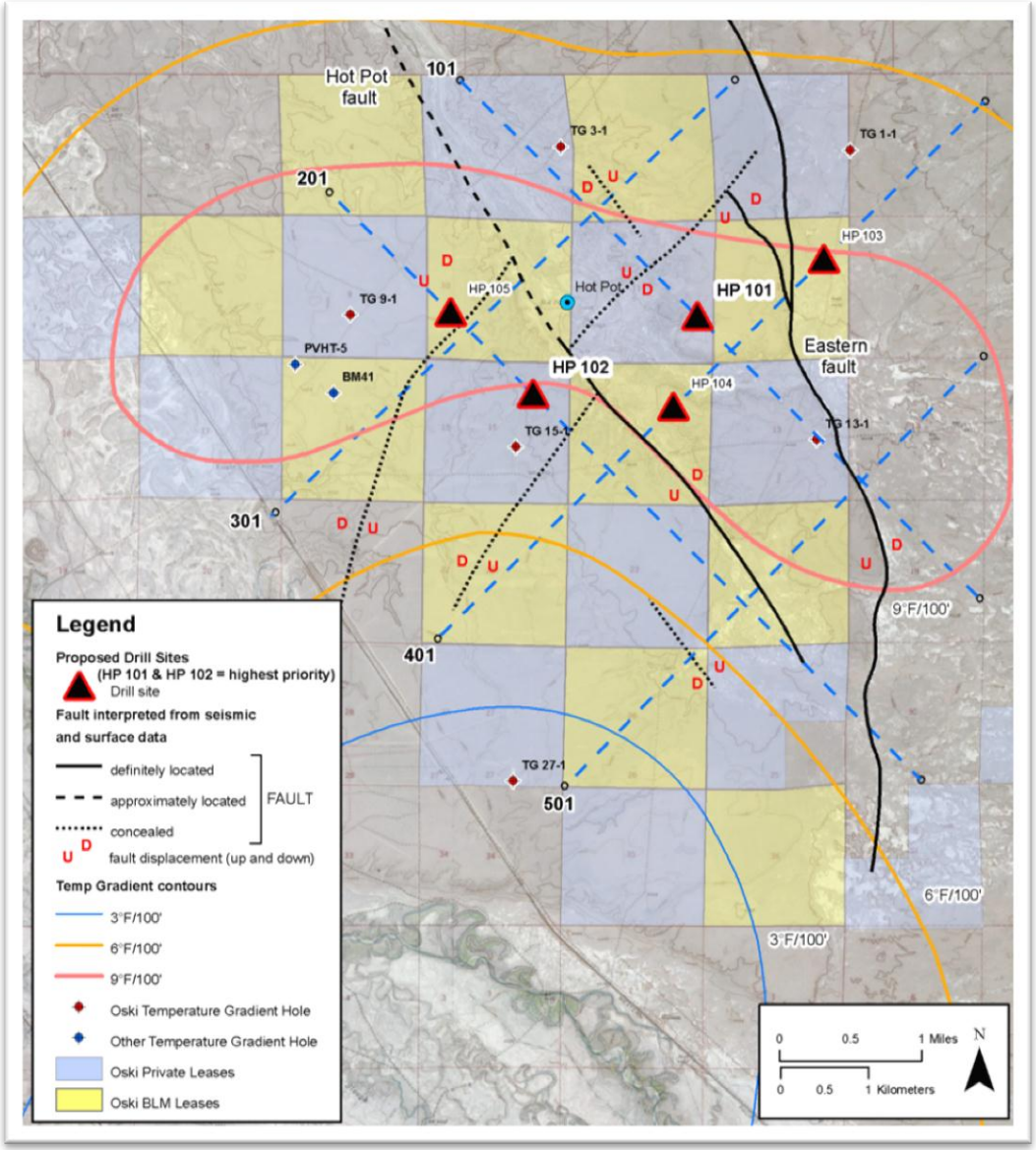
Paleogene Volcanics

Ordovician Valmy Fm.
- Reflective
- Non-reflective

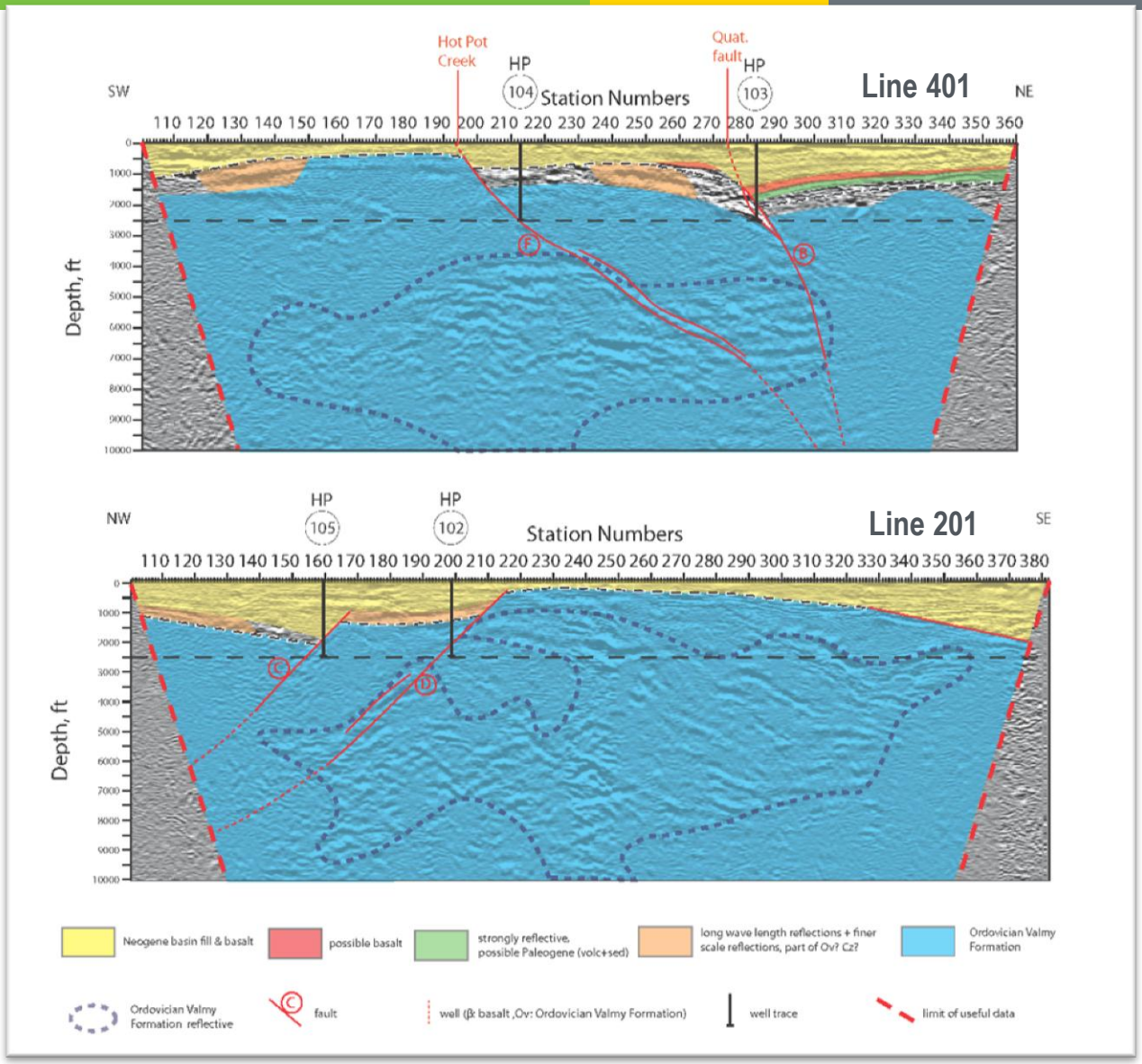
Accomplishments, Results and Progress

- Project Award (January 2010) to May 2011
  - Background data collected and/or generated, seismic survey completed, preliminary intermediate depth temperature gradient hole locations selected, and draft Phase 1 report generated.
- June 2011 to May 2012
  - Stage gate meeting held & Phase 1 report comments addressed.
  - Intermediate temperature hole locations finalized & field checked.
  - Drill pad locations permitted and road access permits obtained.
- June 2012 – April 2013
  - Archeological clearance obtained
  - SHPO package submitted
  - NEPA clearance received
  - Phase 1 stage gate decision pending

Accomplishments, Results and Progress (2)



Accomplishments, Results and Progress (3)



Accomplishments, Results and Progress (4)

- Accomplishments vs. Project Objectives & Technical Target
  - Objective: improve quality/quantity of drilling targets….. ***yes***
  - Technical Target: useful seismic data in difficult geologic environment... ***yes***

- Most important technical challenges this reporting period
  - No technical challenges, worked on archeological, SHPO and NEPA DOE clearances

- Actual technical accomplishments vs. state of the art
  - Industry wide, there is increasing use of reflection seismic in geothermal exploration (well targeting, not greenfield prospecting!)
  - This project is similar to others utilizing the processing approach previously referenced

Accomplishments, Results and Progress (5)

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Original Planned Milestone/ Technical Accomplishment	Actual Milestone/Technical Accomplishment	Date Completed
Permit seismic survey	Seismic survey permits obtained	August 2010
Conduct seismic survey	Seismic survey field work completed	September 2010
Compile existing data	Existing data compiled (& some new data obtained...TG holes, gravity)	December 2010
Interpret new data	New data interpreted, integrated	March 2011
Select drilling targets	Drilling targets selected (slim holes)	April 2011
Submit draft Phase 1 report	Phase 1 report submitted	April 2011
Phase 1 report approval	Approved, pending permitting	June 2011
Complete BLM permitting process	Complete BLM permitting process	May 2012
Complete DOE NEPA process	Complete DOE NEPA process	January 2013
Stage gate conference call	Approval to proceed to Phase 2 (pending)	February 2013

Future Directions

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- FY 2013
  - Receive approval to proceed to Phase 2
  - Prepare to drill slim holes
    - Revise drilling plans
    - Refresh permits where needed
    - Improve and/or construct access roads and drill pads

- FY 2014
  - Drill two intermediate depth slim holes
  - Go/No Go
  - Select location for resource confirmation well
  - Develop drilling program, obtain permits
  - Drill and test well
  - Final report and data transfer

Future Directions (2)

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Milestone or Go/No-Go	Status & Expected Completion Date
Complete revised drilling plans	June 2013
Refresh slim hole drilling permits	July 2013
Access road & pad construction	September 2013
Complete slim hole #1	October 2013
Complete slim hole #2	November 2013
Select & permit deep well location	Pending results of slim holes, February 2014
Complete deep well	July 2014
Well testing & data analysis	August 2014
Complete final report	September 30, 2014

- The major difference between original and planned program is use of core hole drilling instead of mud rotary for slim holes. Significant cost savings are expected.

Summary

- The seismic data acquisition and analysis techniques utilized in this project, if validated by drilling results, offer the potential to:
  - Define structure & stratigraphy in complex geologic environments, including Paleozoic basement
  - Enable intermediate depth slim holes to target specific structures and/or potential reservoir formations in addition to their primary function of temperature gradient confirmation
  - Accelerate the development process by identifying high potential drilling locations early in the exploration phase, facilitating conceptual model refinement, and reducing the number of unsuccessful wells

Project Management

Timeline:

Planned Start Date	Planned End Date	Actual Start Date	Current End Date
January 1, 2010	December 31, 2012	January 29, 2010	September 30, 2013

Budget:

Federal Share	Cost Share	Planned Expenses to Date	Actual Expenses to Date	Value of Work Completed to Date	Funding needed to Complete Work
$4,214,086	$3,985,570	$771,485	$966,125	$1,234,414	$7,428,223

- NOTE: Expenses, value & funding needed are estimates as of 12/31/12, and are subject to revision.
- Value of work includes projects such as shallow temperature gradient holes and a detailed gravity survey which were carried out at Oski expense and were intended to enhance the usefulness of the DOE-funded reflection seismic survey.
- End date of 9/30/14 needed to complete project phases 2 & 3.