Newberry Geothermal

Newberry Volcano EGS Demonstration

May 19, 2010

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AltaRock Energy, Inc

EGS Demonstration Projects

Project Location

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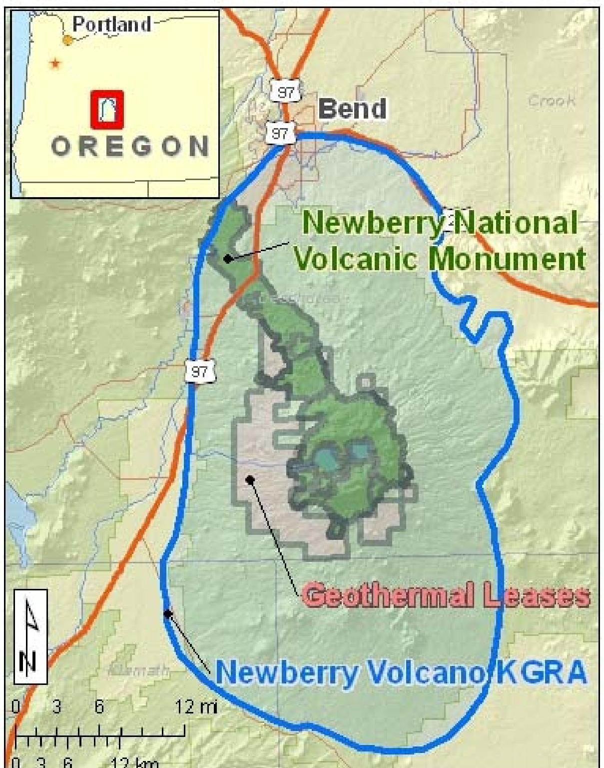
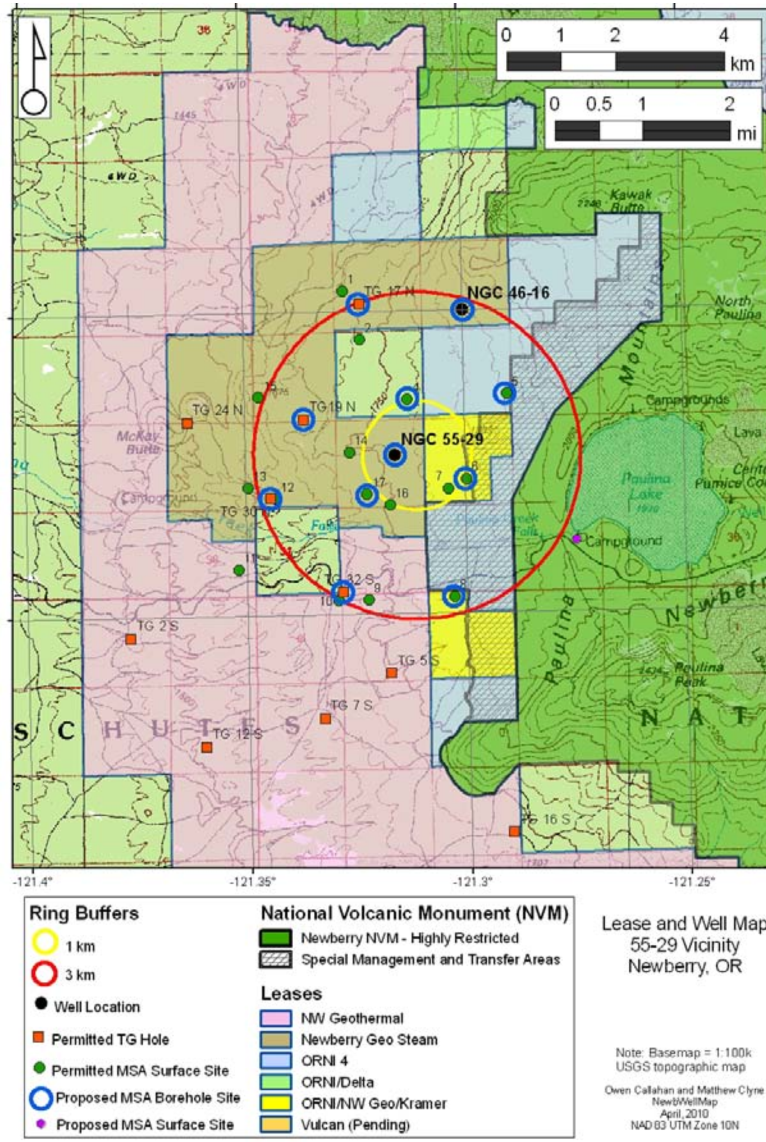
- Northwest flank of Newberry Volcano, Deschutes Co, OR
- Geothermal leases held by Davenport Newberry LLC





Project Overview

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- Timeline
  - Phase I – May 2010 to Feb 2011
  - Phase II – Feb 2011 to Nov 2012
  - Phase III – Nov 2012 to May 2013
  - 1% complete
- Budget
  - Total project funding $43.8m
  - DOE share $21.4m
  - Awardee share $22.4m
  - Funding for FY10 $ 4.1m
- Barriers
  - Institutional
    - Drilling cost – minor grant share for new wells, no share for existing wells
    - Permitting – lack of EGS/induced seismicity policy, minimal support against opposition
  - Technical
    - Many of the technical EGS development barriers cited in the Multi-Year Plan will be encountered and/or addressed (e.g. B, C, D, E, F, G, H, I, J, L, M, P)
- Partners
  - **Davenport Newberry LLC**
    Doug Perry
    Todd Jaffe
  - Temple University
    Nick Devatzes
  - U.S. Geological Survey
    Steve Hickman
  - Lawrence Berkeley National Lab
    Jonny Rutqvist
  - University of Utah / EGI
    Pete Rose
  - Texas A&M
    Ahmad Ghassemi
  - University of Oregon
    Emilie Hooft
  - Foulger Consulting
    Gillian Foulger

Project Management and Tools

AltaRock Project Team

Susan Petty – Principal Invesigator
Will Osborn – Project Manager
Todd Jaffe – Permitting
Adrian Foley – Public Relations
Joe Iovenitti – Geology
Trenton Cladouhos – Stress Analysis
Laura Nofziger – Stimulation
Ben Larson – Geochemistry
Daniel Bour – Zonal Isolation

Technical Advisory Committee

Doug Perry (Davenport Power)
Dave Blackwell (SMU)
Louis Capuano (ThermaSource)
Bill Livesay (AltaRock)
Al Waibel (Columbia Geoscience)

Specialized Tools

AltaStim
TOUGHREACT / TOUGH-FLAC
Chemical Diverters
Mechanical Diverters
Single-Well Test Methods
Quantum Dot Tracers
Distributed Temperature Sensing
Fabry-Perot Pressure Transducer
Borehole Televiewer
Open-Hole Isolation Methods
Expandable Liner Hanger
MSA / Tilt Meters

Project Objectives

To demonstrate the development and operation of an Engineered Geothermal System

- Site and resource investigation
- Stimulation of existing well to create geothermal reservoir
- Production well drilling and completion
- Testing of well productivity and reservoir characteristics
- Conceptual modeling of commercial-scale EGS wellfield and power plant

Primary Goals

- Create EGS fracture network around existing borehole
- Drill two production wells into mapped fracture network
- Produce single-well mass flow rate of 75 Kg/s (595 kph)

Pre-Stimulation 2010 - Spring 2011

- Pre-Stimulation
  - Site and wellbore readiness
  - Site preparation
    - Sump, well pad, roads
    - Water wells
- Stimulation Plan
  - Geoscience review, lab studies, LiDAR
  - Initial Microseismic Array ("MSA") - design, install, monitor
  - Injection well
    - Conduct integrity test
    - Measure baseline (pre-stimulation) injectivity
    - Geophysical logs

Pre-Stimulation 2010 - Spring 2011

- Public Outreach
  - Multimedia presentation of project plan
  - Permitting and planning meetings
  - Public interaction through various media outlets
- Permitting
  - Notice of Intent (exploration, operation, drilling)
  - Groundwater use
  - Surface MSA installation and monitoring (complete)
  - Strong motion sensors
  - Underground injection
  - MSA calibration
  - Subsurface MSA sensors and telemetry
  - Stimulation
  - Drilling
  - Testing
  - Induced seismicity and Seismic Hazards Evaluation
  - Environmental Assessment
- Go/No-Go

Pine Mountain SMS Site

Injection Well Stimulation Spring-Summer 2011

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- Preparation for Stimulation
  - Ongoing site maintenance
  - Materials procurement
  - Installation of subsurface sensors and telemetry
- Injection Well Stimulation
  - Rig mobilization
  - Wellhead installation
  - First stimulation
  - Zonal isolation (chemical, mechanical)
  - Additional stimulations and tracer injection
- Flow test
  - Mass flow, temperature, pressure
  - Well bore surveys
  - Chemical composition and tracer recovery
- Production well drilling plan
- Go/No-Go

Production Wells
Fall 2011- Fall 2012

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- Drill First Production Well
- Geophysical well logs
- Connectivity test
  - Pump groundwater into injector
  - Test production well and recirculate to injector
    - Mass flow, temperature, pressure, water make-up rate
    - Well bore surveys
    - Chemical composition and tracer recovery
- Stimulate production well, if needed
- Update numerical model and evaluate productivity
- Go/No-Go
- Drill second production well
- Conduct multi-well connectivity test
- Go/No-Go

Conceptual Modeling and Long-Term Monitoring

- Post-production reservoir response and long-term monitoring
- Update numerical model and evaluate resource potential
- Develop conceptual models
  - Wellfield expansion
  - Power plan design
  - Forecast reservoir performance
  - Estimate capital and operating cost
- Project Reports
  - Drilling, stimulation and test results
  - Reservoir performance
  - Peer-reviewed publications
  - Data posting to National Geothermal Data System

Meeting DOE EGS Program Objectives

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Project Scope Meets DOE EGS Demonstration Objectives

- ☑ – Demonstrate reservoir creation that achieves a flow rate of 20 kg/s by 2015
- ☑ – Achieve a 10% increase in flow rate for EGS field site demonstration by 2011
- ☑ – Model the reservoir conductivity at an EGS system demonstration by 2011
- ☑ – Determine pre-stimulation reservoir flow rate for at least one EGS field site by 2010

Project Tasks Include DOE Essential Elements of EGS Development

Phase I

- Site Selection - surface analysis, well logs and well construction
  - Construct regional geologic model based on existing data
  - Share in Oregon LiDAR Consortium for enhanced surface feature imaging
  - Evaluate two existing full-size bore holes to select stimulation candidate
  - Temple/USGS borehole televiewer to target stimulation
- Reservoir Characterization - downhole instruments and use of data in modeling
  - Install and calibrate surface and subsurface seismometers
  - Texas A&M rock properties
  - LBNL native state THMC model
  - AltaStim stimulation modeling
  - Induced Seismicity and Seismic Hazards Study

Meeting DOE EGS Program Objectives (cont'd)

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Phase II

- Reservoir Creation - establish permeability and create and maintain cracks
  - Stimulate injection well using chemical (no rig) and mechanical diverters (rig)
  - Monitor fracture growth using focused MSA
- Reservoir Validation - fracture imaging tools
  - Repeat borehole televiewer to assess effects of hydroshearing
  - Inject tracers and execute single-well flow test methods
  - Use distributed temperature sensing to identify flow zones
- Interwell Connectivity - tools to ensure that suitable flow path connects wells, such as tracers
  - Conduct two-well and three-well connectivity tests
  - Analyze conservative and non-conservative tracers to assess effective volume, rate, etc.
  - Conduct dual-well stimulation as necessary

Phase III

- Reservoir Scale-Up and Sustainability - tools for selecting additional locations for wells, and long-term operation and maintenance of an economic EGS installation
  - Calibrate numerical models with real EGS performance data
  - Forecast reservoir performance over typical plant and field design life
- Energy Conversion – suitable energy conversion systems
  - Build conceptual model of commercial-scale power plant and wellfield
  - Estimate capital and operating costs of commercial-scale EGS facility

Mandatory Summary Slide

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- Goal of project: Improve EGS economics by stimulating multiple zones
- Technology Development:
  - Reduce risk by improved fracture mapping and information gather and modeling.
  - Test methods to evaluate the created reservoir
  - Increase our understanding of induced seismicity through better understanding of stresses, natural seismicity and existing faults and fractures