Newberry Volcano EGS Demonstration—Phase I Results

William L. Osborn[1], Susan Petty[1], Trenton T. Cladouhos[1], Joe Iovenitti[1], Laura Nofziger[1], Owen Callahan[1], Douglas S. Perry[2], and Paul L. Stern[3]

[1]AltaRock Energy, Inc.
[2]Davenport Newberry Holdings LLC
[3]PLS Environmental, LLC

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ABSTRACT

Phase I of the Newberry Volcano Enhanced Geothermal System (EGS) Demonstration included permitting, community outreach, seismic hazards analysis, initial microseismic array deployment and calibration, final MSA design, site characterization, and stimulation planning. The multi-disciplinary Phase I site characterization supports stimulation planning and regulatory permitting, as well as addressing public concerns including water usage and induced seismicity. A review of the project's water usage plan by an independent hydrology consultant found no expected impacts to local stakeholders, and recommended additional monitoring procedures. The IEA *Protocol for Induced Seismicity Associated with Enhanced Geothermal Systems* was applied to assess site conditions, properly inform stakeholders, and develop a comprehensive mitigation plan. Analysis of precision LiDAR elevation maps has concluded that there is no evidence of recent faulting near the target well. A borehole televiewer image log of the well bore revealed over three hundred fractures and predicted stress orientations. No natural, background seismicity has been identified in a review of historic data, or in more than seven months of seismic data recorded on an array of seven seismometers operating around the target well. A seismic hazards and induced seismicity risk assessment by an independent consultant concluded that the Demonstration would contribute no additional risk to residents of the nearest town of La Pine, Oregon.

In Phase II of the demonstration, an existing deep hot well, NWG 55-29, will be stimulated using hydroshearing techniques to create an EGS reservoir. The Newberry Volcano EGS Demonstration is allowing geothermal industry and academic experts to develop, validate and enhance geoscience and engineering techniques, and other procedures essential to the expansion of EGS throughout the country. Successful development will demonstrate to the American public that EGS can play a significant role in reducing foreign energy dependence, and provide clean, renewable, baseload geothermal power generation in the State of Oregon.

Introduction

Newberry Volcano is a shield volcano located in central Oregon, about 20 mi (35 km) south of the city of Bend and approximately 40 mi (65 km) east of the crest of the Cascade Range. The Newberry EGS Demonstration is being conducted on federal geothermal leases located in the Deschutes National Forest, adjacent to the Newberry National Volcanic Monument. Extensive exploration activities have been conducted in the Newberry area by public and private entities, including various geoscience surveys, and the drilling of thermal gradient, slimhole, and deep, large-bore wells since the 1970s. AltaRock Energy (ARE), in partnership with Davenport Newberry (Davenport), was awarded a Department of Energy (DOE) grant to demonstrate EGS technology at Newberry. Initial project plans were described in detail in Osborn et al. (2010).

Phase I Activities

In 2010 and early 2011, ARE substantially completed Phase I of the Demonstration. The team's activities, as well as those of the grant sub-recipients, included various field, laboratory and administrative studies. Field studies included installation of a microseismic array (MSA) and monitoring background seismic data, seismic system calibration to develop a velocity model, upgrading water well equipment and testing of the two existing water wells, conducting a baseline injection rate test, pressure-temperature surveys, and cooling the well bore for borehole televiewer (BHTV) imaging. Laboratory studies included development of a native state numerical reservoir model, a fracture stimulation model, developing new reservoir tracers and tracer models, and laboratory analyses of core and cuttings. Permitting and administrative efforts included development of comprehensive plans for conducting Phase II activities, compiling a hydrological study of the local area, the independent seismic and hydrology assessments mentioned above, working with the Bureau of Land Management (BLM), the US Forest Service (FS) and the DOE to conduct an Environmental Assessment of project plans, formulating an Induced Seismicity Mitigation Plan, and assembling a comprehensive report of Phase I activities as a precursor to a DOE ‘stage-gate’ review. ARE has established and maintained a comprehensive public outreach campaign to inform the public about project-related activities by conducting outreach and informational meetings in local communities, publishing project plans and independent consultant reports, and providing relevant educational materials about geothermal and EGS technology on multiple web sites and social media outlets.

Calibration Shot and Background Seismic Monitoring

In cooperation with the U.S. Geological Survey (USGS), a calibration survey of the microseismic surface stations was performed in August 2010. The main calibration shots were 20-24 lbs (9-11 kg) of explosive set off at 12 shot points in 49 ft (15 m) deep shot holes. Figure 1 illustrates which of the 12 shots were recorded at each of the seven MSA stations. An analysis of 36 arrival time measurements on seven ARE seismometers and 182 arrivals on 25 USGS seismometers by Foulger Consulting yielded a robust 5-layer velocity model down to a depth of 2,953 ft (900 m; Table 1).

Table 1. 1-D Seismic Velocity Model.

Depth interval (m)	Depth Interval (feet)	Velocity (km/s)
0 – 150	0 – 492	2.0
150 – 300	492 – 984	2.0
300 – 450	984 – 1,476	3.4
450 – 600	1,476 – 1,969	3.5
600 – 750	1,969 – 2,461	3.7
750 – 900	2,461 – 2,953	3.8
>900	>2,953	unresolved

In addition, the surface MSA minimum magnitude threshold was estimated to be M 0.5 based on analysis of signals from the explosive shots compared to the noise level. To improve the coverage of the regional Pacific Northwest Seismic Network (PNSN) around Newberry Volcano, AltaRock added two seismic stations (2 Hz, three-component sensors), one at River Meadows Home Owners Association in Three Rivers and another at La Pine High School[1]. AltaRock also installed a local MSA, consisting of seven seismic stations (4.5 Hz, three-component sensors) surrounding NWG 55-29, that is currently collecting background seismicity to determine whether any natural microseismicity is occurring under the Demonstration area at magnitudes too low to be detected by the regional network (M<2), but large enough to be detected by surface seismometers (M>0.5).

Seven months of data were downloaded and processed through March 2011. No local events have been detected by the surface MSA. Although the network was designed to detect small local events, not regional and teleseismic earthquakes, the network did detect a February 8, M 5.4 event offshore Oregon and the March 11, M 9.0 earthquake in Japan. A review of historical seismic data, and this background monitoring, demonstrates that Newberry Volcano is currently aseismic. However, the regional and teleseismic events are being analyzed to improve the seismic velocity model.

The surface MSA will continue to operate and the data processed until replaced by a more sensitive array in Phase II. The current plan for the Phase II MSA, based on the optimal network configuration (Figure 2), consists of 6 surface seismometers and 9 borehole seismometers. Deployment in boreholes at least 656 ft (200 m) deep is desirable to reduce noise from surface sources and reduce waveform distortion caused by propagation through weathered rocks near the surface. Figure 2 shows the locations of the proposed stations. The proposed station locations and required permits for the final MSA will be evaluated as part of the permitting process. Surface occupancy and disturbance are limited within the Newberry National Volcanic Monument and in a buffer to the monument. Therefore, station coverage to the east of NWG 5529 is primarily limited to surface MSA stations rather than borehole installations. In addition to the MSA stations, a strong motion sensor (SMS) will be installed at or near the Paulina Lake Visitor Center (PLVC), located within the Monument near frequently occupied structures of concern. Any shaking recorded on this sensor is expected to be about 10 times greater than shaking that might occur in La Pine, making PLVC the optimal SMS monitoring site.

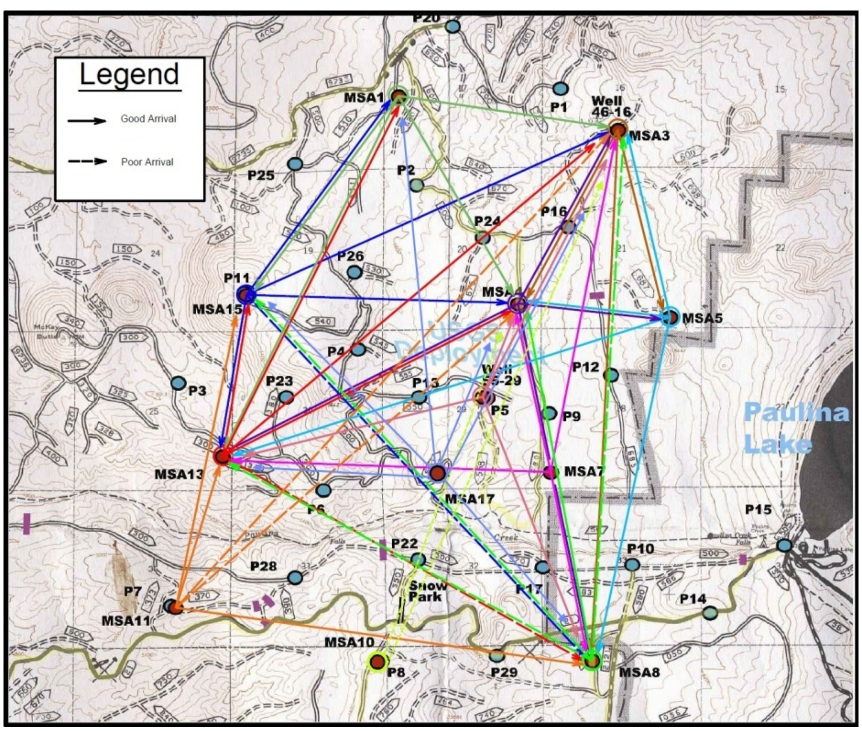

Figure 1. Calibration shot arrivals**.** Stations with colored circles represent shot points, and the associated colored arrows show which stations recorded the arrivals from that calibration shot.

Induced Seismicity Mitigation Plan

ARE developed “*Hydroshearing Controls and Mitigation of Induced Seismicity at the Newberry EGS Demonstration*” (AltaRock, 2011a) to mitigate the risks associated with induced seismicity at the Newberry EGS demonstration. This induced seismicity mitigation plan (ISMP) is based on the current International Energy Agency *Protocol for Induced*

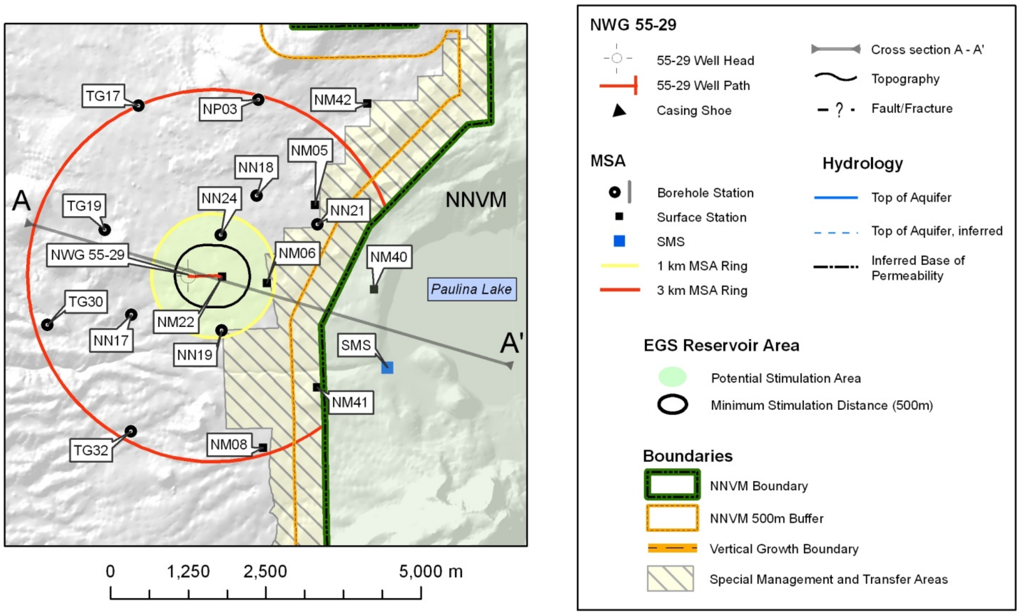

Figure 2. AltaRock final microseismic array design, including borehole installations, as currently planned. Of the ten permitted borehole sites, one is an alternate and will not be occupied. Minimum and potential stimulation areas are shown (light green shaded circle) based on a preliminary stress model of the microseismicity cloud that will be induced and the approximate extent of the EGS reservoir. Hatched area is a 'no surface occupancy' buffer to the Monument, which is in green. Cross-section A-A' is also shown.

Seismicity Associated with Enhanced Geothermal Systems[2] (2009), analysis of past EGS projects, and recent theoretical advances on injection-induced seismicity, including those of Shapiro and Dinske (2009) and Shapiro et al. (2010). The ISMP is being reviewed and refined for publication later this year.

The ISMP defines limits (or 'triggers') that, if reached, will initiate communications with stakeholders, and mitigation actions up to and including stopping injection and immediately flowing the well to reduce reservoir pressure. The triggers will be monitored during hydroshearing and EGS reservoir creation, and throughout the remainder of the Demonstration. These triggers are based on real-time measurement of seismic activity on the PNSN regional network, the local ARE MSA and the PLVC SMS.

Hydrology and Ground Water Monitoring

Groundwater on the flanks of Newberry Volcano around the project area is hosted in young volcanic flows and interspersed sedimentary deposits, with occasional and discontinuous impermeable lithologies. Cross section A-A' (Figure 3) shows the shallow, partially confined to unconfined aquifer on the flanks of Newberry Volcano. Based on review of shallow loss zones during drilling, isothermal temperature profiles, and increasing clay alteration with depth described in mud logs, the mostly unconfined aquifer intersected by the water wells on pads S-16 and S-29 (well numbers DESC 58649 and DESC 58395, respectively) only extends to depths of about 1,000 ft (~300 m) across the project area, with some spatial variability (Dames and Moore, 1994). Below this depth, decreasing permeability caused by increasing clay content forms a basal aquiclude. The top of the aquifer likely fluctuates several meters or more depending on seasonal precipitation.

In the summer of 2010, we conducted a drawdown test of one of the two water wells and an assessment of the transmissivity of the local aquifer. A drawdown test of the Pad S-29 water well showed that the specific capacity of the well is 16 gpm per foot of drawdown. Transmissivity and conductivity were estimated, respectively, at 6,485 ft^2/day (602 m^2/day) and 162 feet/day (49 m/day) for a 40 foot (12 m) thick aquifer. Transmissivity estimates from this study are 5-10 times higher than results from Gannett et al. (2000). However, this is not unexpected given the heterogeneous nature of aquifer lithologies across the basin. A second drawdown test is planned for both water wells in summer 2011.

As part of the permitting process, a water usage plan was developed for all Phase II activities (AltaRock, 2011b). Many variables will affect actual water usage, including reservoir size (cumulative fracture volume), system leak-off rate, production enthalpy and resulting steam fraction, and the duration of circulation testing. The water usage plan predicts that Phase II will utilize

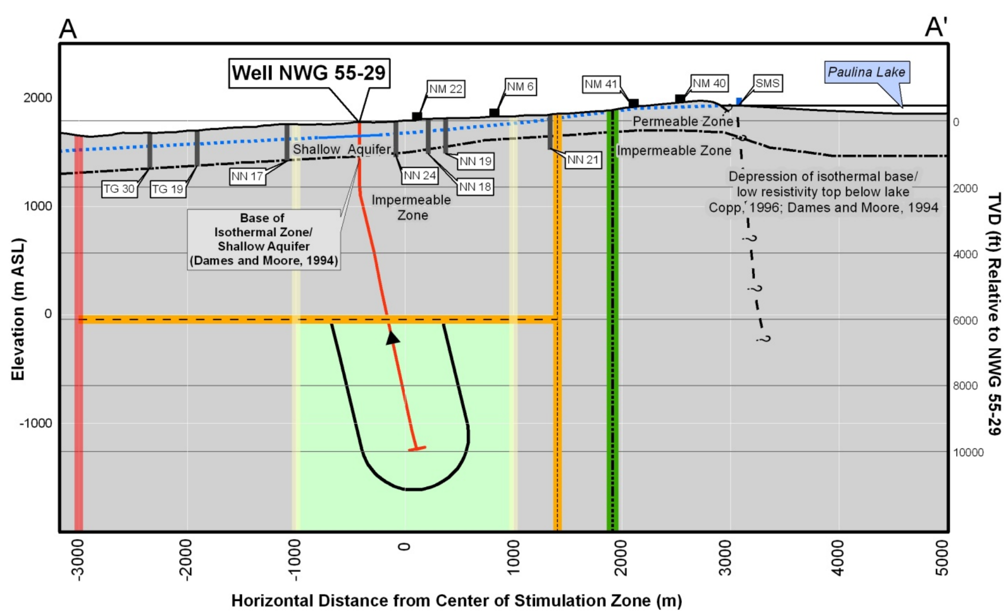

Figure 3. Cross section A-A' (Figure 2 shows line) showing groundwater aquifer, well bore profiles and target stimulation zone. Legend shown in Figure 2.

between 223 and 425 acre-ft of water. The stimulation of NWG 55-29 is expected to use less than 74 acre-ft, while the long-term circulation test, due to evaporation, will use between 52 and 242 acre-ft, depending on test duration (30 versus 60 days) and steam fraction (estimated to be between 16.3% and 37.6%). In January 2011, Kleinfelder Inc. was selected to provide an independent assessment of the water usage plan, and to assess potential impacts of the Demonstration on local and regional hydrology (Kleinfelder, 2011). They assessed the source of water that will be used, the effects of water use on local and regional aquifers, and how monitoring should be conducted to quantify effects during planned operations. The study also evaluated the evolution of the water that will be injected into the EGS reservoir, including the potential for water migration outside the planned EGS fracture network and unlikely impacts to the overlying shallow groundwater aquifer, the caldera lakes, and adjacent stakeholders. Their report, which reviewed the drawdown testing data to date, the proposed sampling plan and addressed several public scoping questions, was submitted to the BLM and posted to public sites in February 2011. Their report concluded that there will be no detrimental impacts to the hydrologic environment from planned Demonstration activities.

LiDAR Data Collection

LiDAR data collection in the Newberry area was completed in 2010 by the Oregon LiDAR Consortium, in which ARE participated. The complete data set was received in December, 2010. Identifiable fault scarps in the LiDAR dataset are limited to known fault areas west of La Pine. Longer, northwest-trending faults identified in the USGS *Quaternary Fault and Fold Database* in the La Pine basin are not evident in LiDAR data. Readily distinguishable fissures are generally limited to younger basalt flow sources in the northwest rift but also occur on scattered cinder cones around the mapped area. Faults west of La Pine and fissure orientations on the Newberry edifice are both consistent with a regional east-west extension direction. The results of the ARE lineament analysis are reported in Cladouhos et al. (2011) and were incorporated into the ISMP. The raw LiDAR data has been shared with Oregon State University for inclusion in a student-led regional analysis of volcanic and tectonic features.

Reservoir Modeling

ARE constructed a preliminary conceptual geologic model of Newberry, and Demonstration subrecipients at LBNL used this to create a native state numerical model of reservoir conditions prior to stimulation. Gridding the system around NWG 55-29, establishing boundary conditions, and building the thermodynamic database will form the basis of the coupled thermal-hydrologic-chemical model. The entire pressure-temperature regime around NWG 55-29, including a hypothesized supercritical region, was simulated using a recently developed supercritical version of TOUGH2. A well-tested native state THC model then will provide a strong foundation for a more comprehensive thermal-hydrological-mechanical-chemical model (THMC) for stimulation. A mechanical model is under development for analysis of the THMC effects of stimulation; the next step is to add specific gas species such as CO_2 and SO_2 to the reactive transport model to simulate water chemistry and water-rock interaction.

In addition to the LBNL work, ARE is participating in two related projects, one at Pennsylvania State University and another at Texas A&M, modeling the THMC responses to EGS reservoir creation and circulation. These three modeling efforts will complement each other and greatly enhance the quality of predictive stimulation and coupled reservoir models for the Newberry EGS demonstration.

Injectivity Testing, Pressure-Temperature and Borehole Televiewer Surveying

A static pressure-temperature (PT) survey was conducted with memory tools in NWG 55-29 to record the temperature profile, identify fluid level, and ensure that the well was open to total depth. A conductive gradient and maximum temperatures in excess of 600°F (>316°C) at total depth were observed, identical to that measured after well completion in 2008. An injection test was conducted to measure baseline injectivity prior to stimulation. Cool (50°F, 10°C), groundwater produced from the onsite water well was injected at approximately 10 gpm (0.63 L/s) at a surface pressure of 750 psi (51.7 bar) for three days, after which time an injecting pressure-temperature survey was conducted to determine if injection was indeed cooling the well bore. The PT survey showed water exiting the well from 9,280 to 9,560 ft (2,829 to 2,914 m). In this depth range, the mud log identifies many small felsic dikes, and the contacts between three large granodiorite dikes and subvolcanic basalt, including one contact with a highly altered zone containing abundant epidote. The intrusive contacts are prime stimulation targets because of the likely presence of thermal cracking, alteration and weakening. Before and during injection testing, ARE used the Petris DrillNet software package to successfully model the expected cooling during injection. Modeling results were confirmed by Dr. Brian Anderson at West Virginia University, who used an internally-developed software package to validate the data.

After conducting the injecting PTS survey, and demonstrating that low-rate injection would successfully cool the well, injection was discontinued. It was then re-started three weeks later under the same conditions to cool the well bore in preparation for BHTV logging. For three days, a higher injection rate of 21 gpm (1.3 L/s) at a surface pressure of 1,153 psi (79.5 bar) was achieved. Natural injectivity was calculated to be 0.02 gpm/psi, which is comparable to injectivities measured in surrounding Newberry wells and to pre-stimulation injectivities at other EGS sites (Tables 2 and 3; Spielman and Finger, 1998). A third PT survey was conducted just prior to BHTV logging to ensure that the well was cool enough for tool deployment. Fluid was found to be exiting from 8,640 to 8,800 ft (2,633 to 2,682 m) and from 9,280 to 9,560 ft (2,829 to 2,914 m). The zone from 8,640 to 8,800 ft (2,633 to 2,682 m) did not appear to accept injection when water was injected at 750 psi (51.7 bar) and 10 gpm (0.63 L/s), but did when water was injected at 1,153 psi (79.5 bar) and 21 gpm (1.3 L/s). Since the zone from 8,640 to 8,800 ft (2,633 to 2,682 m) did not show any cooling during initial injection, it appears that 750 psi (51.7 bar) was not enough pressure to shear and dilate existing fractures in that section of the open-hole, but at 1,153 psi (79.5 bar) may be approaching the shear failure pressure.

Table 2. NWG 55-29 Injectivity into Open Hole from 6,462 to 10,060 feet (1,970 to 3,066 m)

Average WHP (psig)	Injection Rate (gpm)	Injectivity (gpm/psig)
751	14	0.019
821	17	0.021
1,153	21	0.018

Temple University and USGS conducted a BHTV survey of NWG 55-29 using the SANDIA-DOE ABI85 instrument in October 2010. Injection continued during televiewer deployment to keep the well bore cool and allow more of the open-hole interval to be surveyed. At an instrument external temperature of 531°F (277°C), the tool motor stopped working and logging ceased. The resulting log spans the upper 2,425 ft (739 m) portion of the 3,629 ft (1,106 m) open-hole interval from the casing shoe at 6,462 to 8,870 ft (1,970 to 2,704 m). This log was analyzed in combination with a suite of geophysical logs including array induction, litho-density, neutron porosity, spontaneous potential, natural gamma, 1-arm caliper, and temperature-pressure-spinner logs. The televiewer log identified 351 fractures, 111 of which have an apparent aperture greater than zero at the well bore interface. Many of the fractures are well-oriented for normal slip in an east-west tensional regime and represent stimulation targets because they are weak points in the rock matrix, but, as indicated by all previous well logging and testing, they are currently incapable of flow and lack significant permeability. The felsic dikes from 8,375 to 8,500 ft (2,553 to 2,591 m) contain the highest concentration of fractures in the televiewer data. Hence, it is expected that other felsic dikes deeper in the open-hole interval will also be prime stimulation targets. The fractures identified in the BHTV have a wide variety of orientations and dips. The dominant strike direction is north-northeast, consistent with the regional fault trends and stress directions (Cladouhos et al., 2011). The median dip is 60°, consistent with a normal faulting regime. There are more east-dipping (toward-the-caldera) fractures (40%), than west-dipping fractures (30%), and, if corrected for the orientation bias introduced by the deviated well, more than half of the fractures are east-dipping.

Table 3. Injectivity Data from Offset Newberry Wells and Temperature Core Holes (Spielman and Finger, 1998)

Well	Date	Open Hole (feet KB)	Injection Rate (kph)	WHP (psig)	Injectivity (kph/psig)	Injectivity* (gpm/psig)
76-15 TCH	11/18/95	5,116-5,360	1	300	0.0015	0.0030
76-15 TCH	11/18/95	2,748-4,800	2	300	0.0031	0.0062
CEE 86-21	12/2/95	4,199-9,020	42.5	50	0.11	0.2196
CEE 86-21	4/18/96	5,701-9,185	25	800	0.022	0.0439
CEE 23-22	1/8/96	4,418-9,602	60	200	0.026	0.0519
CEE 23-22	1/21/96	4,418-9,602	40	1,350	0.024	0.0479

*Water level was approximately 775 ft in all the wells, therefore liquid head at zero WHP was assumed to be 333 psi. This is added to the WHP to calculate injectivity.

No tensile drilling cracks were observed, but clearly defined borehole breakouts are distributed throughout the image log. Breakouts show a consistent azimuth independent of borehole deviation (which ranges from 10.5° to 15.1°), and indicate that the minimum horizontal stress, S_{hmin}, is oriented at an azimuth of 092° ±16.6°. The project team has analyzed the fracture and stress magnitude data and modeled the stimulation using AltaStim, a stochastic fracture and flow software model developed by AltaRock to aid in the development of a stimulation plan (Cladouhos et al., this volume).

Core Mechanical Properties and Analysis of Cuttings

Mineralogical and mechanical analysis of cuttings and core sourced from wells drilled by Davenport and the UURI core library was initiated in 2010 at University of Utah, Temple University and Texas A&M University. Texas A&M is now developing a test protocol to determine the strength of cylindrical rock samples with artificial inclined joints (open joints). This new laboratory test is intended to provide data useful in quantifying the strength and deformation properties of rock with joints, one of the most important types of discontinuity within rock masses. These properties are used as fixed inputs in AltaStim for stimulation modeling, and in TOUGH2 for the THC and THMC reservoir modeling.

Letvin (2011) analyzed the mineralogy of drilling cuttings and related geophysical logs to investigate the alteration history of NWG 55-29. This study found that the mineral assemblages do not match the current well temperatures and that minerals were deposited during a cooler time in the geothermal field. Because the formations rocks are largely impermeable, the mineralogy has not been impacted by hot geothermal fluids. Based on the results, XRD and XRF analysis of cuttings from additional intervals in NWG 55-29 is being conducted.

Tracer Methods for Characterizing Fracture Creation in EGS

Several important steps were completed in the development of tracer methods for EGS in 2010. The tracers and tracer methods will be applied at the Newberry Demonstration site during the stimulation and subsequent flow-back testing of NWG 55-29 to calculate the surface area of the created reservoir. To that end, a laboratory model was constructed for the measurement of tracer concentration. Simple 1D numerical models were developed to simulate tracer breakthrough curves in an inter-well setting for a conservative and sorbing tracer pair, using TOUGH2 and TOUGH-REACT. Tracers will also be utilized during the connectivity and long-term circulation tests in a more conventional way to determine fluid breakthrough times and to qualify system transmissivity. Several sorbing tracers were identified and screened for use. The most promising sorbing tracer was subjected to further laboratory testing. Its sorption effectiveness on quartz sand was evaluated at various temperatures and grain sizes. Future tests will be conducted on lithologies comparable to those found at Newberry Volcano, to assess how mineralogy affects reactivity and absorption capability.

Permitting

In June 2010, Davenport and AltaRock submitted a Notice of Intent to Conduct Geothermal Resource Exploration Operations to the Bureau of Land Management (BLM). This action initiated the environmental permitting process with the BLM and two co-operating federal agencies, the DOE and FS. All three agencies have responsibilities under the National Environmental Policy Act (NEPA) to conduct environmental analysis and make a determination and decision based on the findings of that analysis. Because three federal agencies are involved, a lead and cooperating agencies were designated, and each has its own specific purposes for involvement. The BLM, acting as the lead agency for NEPA review, is currently in the process of preparing an Environmental Assessment (EA) of the project.

In support of the EA, several independent specialist reports were prepared. An independent consultant, URS, was contracted to conduct an assessment of the induced seismicity hazards and risks (URS, 2010). The study, completed in December 2010, concluded that planned induced seismicity added no measureable risk to existing natural seismic hazards. The contractor attended a regulatory planning meeting and explained the results to attendees. URS then performed a follow-up study that included the development of a shake map for nearby communities, an evaluation of hazards to recreational users of the area during stimulation, and a qualitative assessment of risks to structures in the caldera (URS, 2011). This follow-up study was completed in January 2011 and submitted to the BLM. Kleinfelder conducted an independent review of existing hydrologic resources within the upper Deschutes Basin and potential effects of the project on local water resources (Kleinfelder, 2011). The report concluded there would be no detrimental effects to local hydrologic features. Finally, a scenic resource assessment was conducted for the project area by Robert Scott Environmental Services. The report concluded that impacts to scenic resources would be minimal and project activities are not expected to draw attention or adversely affect the viewing experience.

The EA contains documents discussing water usage, induced seismicity mitigation protocols, test equipment, alternative evaluation, and chemical information about the tracer and diverter materials to be used during the stimulation of NWG 55-29. AltaRock met with BLM, FS and DOE representatives in March 2011 to discuss the EA sub-reports, primarily focusing on water usage and induced seismicity. AltaRock and Davenport are currently preparing various data and information packages for the Phase I reporting effort, including final revisions to the ISMP. Submittal of the Phase I report to DOE will initiate the stage-gate review process, a prerequisite to Phase II activities.

In addition to initiating the NEPA process with the federal agencies, the project team worked with state agencies to secure the necessary environmental permits on the state level. The Oregon Water Resources Department issued a limited water use license to supply the necessary groundwater required by the Demonstration project. Oregon Department of Environmental Quality (DEQ) issued a temporary underground injection control permit for the baseline injection test at NWG 55-29. AltaRock will continue to work with the federal and state agencies to secure the necessary environmental permits for the subsequent phases of the project.

Public Outreach

Four community outreach meetings have been held in La Pine, Sunriver, Bend, and at the Demonstration site to communicate plans with regulatory agencies and local stakeholders, and provide educational opportunities on the Demonstration plans and benefits. Public concerns have been primarily related to water consumption, evolution of water used for stimulation, induced seismicity, and potential visual and recreational impacts to the nearby Monument. We have addressed the primary concerns related to water and induced seismicity by commissioning independent assessments of our project plans by Kleinfelder and URS, respectively. These studies, subsequently published on our web sites and announced through social media, investigated potential impacts to the environment and, where appropriate, recommended additional mitigation measures, which ARE has incorporated into project plans.

Two web sites and several social media outlets have been established to actively communicate Demonstration plans and activities. We routinely provide project updates to a contact list of over 225 recipients. AltaRock has posted project plans and technical reports to the Demonstration websites[3] and social media sites[4] to keep the public informed of recent developments, and to relay related information about geothermal energy, enhanced geothermal systems, and related energy issues. Search engine optimization techniques are used to enable concerned stakeholders to readily access project information. Positive public support is evidenced by increasing numbers of the public actively following the posts. These sites will be continuously updated through the lifetime of the Demonstration to keep the public and regulators informed, including frequent text and video updates during periods of major field activities such as stimulation, drilling and flow testing. A public meeting will be held shortly after the Environmental Assessment has been released for public review. Before well stimulation begins, notices will be published in the local newspapers and contact information (phone numbers, email addresses, websites, etc.) provided for interested citizens to receive more information and report concerns. Public meetings will be held monthly during active Phase II field operations.

To date, AltaRock and Davenport have also provided more than 20 presentations at public venues and professional meetings, including the outreach meetings mentioned above, the 2010 Geothermal Resources Council Annual Meeting, Oregon Geothermal Working Group meetings, and the 2011 Stanford Geothermal Workshop. The project team meets regularly with county, state and federal elected leaders, and other stakeholders, including environmental groups, to inform them of our progress and plans.

Phase II Activities

The primary objective of Phase II is the creation an EGS reservoir, and demonstration of efficient extraction of heat from the underlying resource at economically viable flow rates using three hydraulically-connected wells. Tasks to be completed in Phase II represent the core of the EGS reservoir development effort, including four principal subtasks: 1) stimulation and testing of the target injection well; 2) drilling and testing of the first production well; 3) drilling and testing of the second production well; and, 4) a 30-day circulation test involving the injection well and both production wells. For the remainder of 2011, ARE plans to finalize the microseismic array by installing 9 borehole seismometers and 6 surface seismometers, followed by the stimulation of NWG

55-29, when testing of the diverter materials and tracer modeling methods will be accomplished.

Summary

During Phase I, the Newberry project team studied existing data and gathered new regional and well bore data to develop a comprehensive geoscience and reservoir engineering model of the resource underlying the Demonstration site. ARE formulated a detailed plan to conduct Phase II operations, which includes seismic monitoring, stimulation, drilling and testing. Concurrently, the team assembled a large array of project information to conduct public outreach and inform permitting agencies. The completed tasks include implementing a public relations campaign by distributing information and determining stakeholder concerns through the use of public meetings, web site and social media and providing detailed project plans and background information to aid the Environmental Assessment process and the Phase I stage-gate review.

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