Evaluation of Oil-Industry Stimulation Practices for Engineered Geothermal Systems

PROJECT SUMMARY

Geothermal energy extraction is typically achieved using long open-hole intervals in an attempt to connect the wellbore with the largest possible rock mass. This presents a problem for the development of EGS, owing to the challenge of obtaining uniform stimulation throughout the open-hole interval. Fluids are often injected in only a fraction of that interval, reducing heat transfer efficiency and increasing energy cost. Pinnacle Technologies and GeothermEx propose to evaluate a variety of techniques and methods that are commonly used in hydraulic fracturing of oil and gas wells to increase and evaluate stimulation effectiveness in EGS wells. Headed by Leen Weijers, Manager of Technical Development at Pinnacle Technologies, the proposed project will run from 8/1/2004 to 7/31/2006 in two 1-year periods to address the following tasks and milestones:

- Analyze stimulation results from the closest "oil-field equivalents" for EGS applications in the United States (e.g. the Barnett shale in North Texas). Pinnacle has collected fracture growth data from thousands of stimulations; these data will be further evaluated in the context of (i) identifying techniques best-suited to developing a stimulated EGS fracture network; and (ii) quantifying the growth of the network under various conditions to develop a calibrated fracture network growth model. The developed model will be used to design optimized EGS fracture network that maximizes contact with the heat source and minimizes short-circuiting.

- Evaluate methods used in oil field applications to improve fluid diversion and penetration and determine their applicability to EGS. These methods include, but are not limited to: (i) stimulation strategies (propped fracturing vs. water fracs vs. injecting fluid below frac gradients); (ii) zonal isolation methods (using perforated casing or packers); (iii) fracture reorientation and fracture network growth techniques (e.g. using alternating high- and low-rate injections); and (iv) fluid diversion methods (using the Surgifrac technique, the StimGun perforation technique or stress shadowing). This task will be completed in year 1, enabling the most promising techniques to be field tested and evaluated in year 2.

- Study the applicability of methods listed above utilizing several techniques, including, but not limited to: (i) Hydraulic Impedance Testing (HIT) to determine the location of open hydraulic fractures along a open-hole interval; (ii) pressure transient testing to determine reservoir permeability, pore pressure and closure stress; (iii) evaluate fracture coverage using treatment well tilt mapping or micro-seismic mapping. These techniques will be reviewed for their potential application in EGS in year 1. This study will also include further analysis of any field testing that will be conducted in the Desert Peak area in Nevada for ORMAT Nevada, with the aim to "close the loop" to provide a reliable calibrated fracture model results.

Developed through its hydraulic fracture consulting business, Pinnacle's techniques for stimulating and analyzing fracture growth have helped the oil and gas industry to improve hydraulic fracturing from both a technical and economic perspective. In addition to 30+ years of experience in the development of geothermal energy for commercial power generation throughout the world, GeothermEx brings to the project detailed information about specific developed and potential EGS reservoirs, experience with geothermal well design, completion and testing practices, and a direct connection to the Desert Peak EGS project.