Drilling And Testing Geothermal Wells Home Esmap

This report deals the preliminary geological and geophysical work needed to ascertain the characteristics of the geothermal reservoir below the town of Pagosa Springs, Colorado. cf. Introd.

The principal objectives of the geopressured-geothermal reservoir resource assessment program are to obtain data related to the following: 1.2.1--Reservoir parameters and characteristics, including permeability, porosity, areal extent, net thickness of productive sands, methane content, and formation compressibilities; 1.2.2--Ability of a geopressured well to flow at the high rates, i.e., 40,000 bbls/day, expected to achieve the resource recovery required for economic commercial operations; 1.2.3--Reservoir production drive mechanisms and physical and chemical changes that may occur with various production rates and conditions; 1.2.4--Aquifer fluid properties, including chemical composition, dissolved and suspended solids, hydrocarbon content, in situ temperature, and pressure; 1.2.5--Techniques and strategies for completion and production of geopressured wells for methane, thermal, and hydraulic energy production, including examination of producibility using computer simulators employing parameters determined by well testing; 1.2.6--Disposal well parameters, such as optimum injection rate and pressures (transient and pseudo steady state), chemical compatibility of fluids, temperature-solubility relationships, and the economic considerations of injection, including evaluation of filtering and inhibition techniques in the process steam; and 1.2.7--The long-term environmental effects of an extensive commercial application of geopressured-geothermal energy, i.e., subsidence, induced seismicity, and fluid disposal.

As nations alike struggle to diversify and secure their power portfolios, geothermal energy, the essentially limitless heat emanating from the earth itself, is being harnessed at an unprecedented rate. For the last 25 years, engineers around the world tasked with taming this raw power have used Geothermal Reservoir Engineering as both a training manual and a professional reference. This long-awaited second edition of Geothermal Reservoir Engineering is a practical guide to the issues and tasks geothermal engineers encounter in the course of their daily jobs. The book focuses particularly on the evaluation of potential sites and provides detailed guidance on the field management of the power plants built on them. With over 100 pages of new material informed by the breakthroughs of the last 25 years, Geothermal Reservoir Engineering remains the only training tool and professional reference dedicated to advising both new and experienced geothermal reservoir engineers. The only resource available to help geothermal professionals make smart choices in field site selection and reservoir management Practical focus eschews theory and basics- getting right to the heart of the important issues encountered in the field Updates include coverage of advances in EGS (enhanced geothermal systems), well stimulation, well modeling, extensive field histories and preparing data for reservoir simulation Case studies provide cautionary tales and best practices that can only be imparted by a seasoned expert

Principles, Applications, Case Studies and Environmental Impact

Geothermal Energy Geopressure Subprogram. Gulf Coast Well Drilling and Testing Activity (Frio, Wilcox, and Tuscaloosa Formations, Texas and Louisiana).

Vale Exploratory Slimhole: Drilling and Testing

City of Alamosa, Colorado : Alamosa #1 Geothermal Test Well

INEL/Snake River Plain Geothermal Drilling and Testing Plan, INEL-1 Well

Cour constitutionnelle Hongrie

Overview of Drilling and Completion Practices in Geopressured-geothermal Wells

The Dow/D.O.E.L.R. Sweezy No. 1 geopressured geothermal production well was completed in August of 1981. The well was perforated and gravel packed in approximately 50 feet of sand from 13,344 feet to 13,395 feet. Permeabilities of 6 to 914 millidarcies were measured with porosity of 25 to 36%. Static surface pressure after well clean-up was 5000 psi. At 1000 B/D flow rate the drawdown was 50 psi. The water produced in clean-up contained 100,000 ppm TDS. This report details the plan for testing this well with the goal of obtaining sufficient data to define the total production curve of the small, 939 acre, reservoir. A production time of six to nine months is anticipated. The salt water disposal well is expected to be completed and surface equipment installed such that production testing will begin by April 1, 1982. The program should be finished and reports written by February 28, 1983. The brine will be produced from the No. 1 well, passed through a separator where the gas is removed, then reinjected into the No. 2 (SWD) well under separator pressure. Flow rates of up to 25,000 B/D are expected. The tests are divided into a two-week short-term test and six to nine-month long-term tests with periodic downhole measurement of drawdown and buildup rates. Data obtained in the testing will be relayed by phoneline computer hookup to Otis Engineering in Dallas, Texas, where the reservoir calculations and modeling will be done. At the point where sufficient data has been obtained to reach the objectives of the program, production will be ended, the wells plugged and abandoned, and a final report will be issued.

During April-May, 1995, Sandia National Laboratories, in cooperation with Trans-Pacific Geothermal Corporation, drilled a 5825[prime] exploratory slimhole (3.85 in. diameter) in the Vale Known Geothermal Resource Area (KGRA) near Vale, Oregon. This well was part of Sandia's program to evaluate slimholes as a geothermal exploration tool. During drilling we performed several temperature logs, and after drilling was complete we performed injection tests, bailing from a zone isolated by a packer, and repeated temperature logs. In addition to these measurements, the well's data set includes: 2714[prime] of continuous core (with detailed log); daily drilling reports from Sandia and from drilling contractor personnel; daily drilling fluid records; numerous temperature logs; pressure shut-in data from injection tests; and comparative data from other wells drilled in the Vale KGRA. This report contains: (1) a narrative account of the drilling and testing, (2) a description of equipment used, (3) a brief geologic description of the formation drilled, (4) a summary and preliminary interpretation of the data, and (5) recommendations for future work.

Volume 1 Drilling and Completion, DOW Chemical Company -- Department of Energy DOW-DOE Sweezy No. 1 Well, Vermillion Parish, Louisiana

Fundamentals, Applications and Advanced Techniques

An Environmental Report on the Drilling and Production Testing of an Exploratory Geothermal Well in Pagosa Springs, Colorado

Environmental Assessment

Field Testing Advanced Geothermal Turbodrill (AGT). Phase 1 Final Report

Annual Report

Ron DiPippo, Professor Emeritus at the University of Massachusetts Dartmouth, is a world-regarded geothermal expert. This single resource covers all aspects of the utilization of geothermal energy for power generation from fundamental scientific and engineering principles. The thermodynamic basis for the design of geothermal power plants is at the heart of the book and readers are clearly guided on the process of designing and analysing the key types of geothermal energy conversion systems. Its practical emphasis is enhanced by the use of case studies from real plants that increase the reader's understanding of geothermal energy conversion and provide a unique compilation of hard-to-obtain data and experience. An important new chapter covers Environmental Impact and Abatement Technologies,

including gaseous and solid emissions; water, noise and thermal pollutions; land usage; disturbance of natural hydrothermal manifestations, habitats and vegetation; minimisation of CO2 emissions and environmental impact assessment. The book is illustrated with over 240 photographs and drawings. Nine chapters include practice problems, with solutions, which enable the book to be used as a course text. Also includes a definitive worldwide compilation of every geothermal power plant that has operated, unit by unit, plus a concise primer on the applicable thermodynamics. * Engineering principles are at the heart of the book, with complete coverage of the thermodynamic basis for the design of geothermal power systems * Practical applications are backed up by an extensive selection of case studies that show how geothermal energy conversion systems have been designed, applied and exploited in practice * World renowned geothermal expert DiPippo has including a new chapter on Environmental Impact and Abatement Technology in this new edition

Geothermal Well Test Analysis: Fundamentals, Applications and Advanced Techniques provides a comprehensive review of the geothermal pressure transient analysis methodology and its similarities and differences with petroleum and groundwater well test analysis. Also discussed are the different tests undertaken in geothermal wells during completion testing, output/production testing, and the interpretation of data. In addition, the book focuses on pressure transient analysis by numerical simulation and inverse methods, also covering the familiar pressure derivative plot. Finally, non-standard geothermal pressure transient behaviors are analyzed and interpreted by numerical techniques for cases beyond the limit of existing analytical techniques. Provides a guide on the analysis of well test data in geothermal wells, including pressure transient analysis, completion testing and output testing Presents practical information on how to avoid common issues with data collection in geothermal wells Uses SI units, converting existing equations and models found in literature to this unit system instead of oilfield units

Experience in the DOE's Wells of Opportunity program, drilling and testing geopressured-geothermal reservoirs is reviewed and some conclusions concerning drilling and completion practices, ways to cut operating costs for these tests, and long-term production applications are presented.

Testing Geopressured Geothermal Reservoirs in Existing Wells

User Coupled Confirmation Drilling Program Case Study

Detailed Completion Prognosis for Geopressured-geothermal Well of Opportunity, Prospect #7

INEL/Snake River Geothermal Drilling and Testing Plan

Overview of Drilling and Completion Practices in Geopressured-geothermal Wells

Drilling, Logging and Preliminary Well Testing of Geothermal Well Susan 1, Susanville, Lassen County, California

This paper briefly discusses logging and testing operations and certain related physical aspects in geothermal well evaluations. A good understanding of thermal and hydrological characteristics of geothermal reservoirs are essential in geothermal well evaluations. Within geothermal reservoirs, in evaluating the wells, the two most important parameters that first could be estimated, then measured or calculated, are temperature and productivity. Well logs and wireline surveys are means of measuring formation temperatures. Drill Stem Tests (DST's) or Pit Tests are means of determining formation productivity. Geochemistry and Petrology are currently accepted as two evaluation yardsticks in geothermal well evaluations. investigations of cuttings and cores during drilling operations, along with studies on formation waters could be used in a predictive nature for temperature and productivity and could yield useful information on the resource.

Gladys McCall site activities are covered through the completion of the test well and salt water disposal well. The test well was drilled to a total depth of 16,510 feet, then plugged back to 15,831 feet. Three 4" diameter diamond cores were taken for analysis. An existing well on site, the Getty-Butts Gladys McCall No. 1, was reentered and completed to a depth of 3514 feet as a salt water disposal well. The geologic interpretation of the Gladys McCall site indicated target sands for testing at 15,080 feet through 15, 831 feet. Reservoir fluid temperature at this depth is estimated to be approximately 313°F and pressure is estimated to be +-12,800 psi. The preliminary reservoir volume estimate is 3.6 billion barrels of brine. The design wells program includes environmental monitoring of the Gladys McCall site by Louisiana State University. Field stations are set up to monitor surface and ground water quality, subsidence, land loss and shoreline erosion, and seismicity. As of December 31, 1981 the study shows no significant impact on the environment by site operations.

The work reported herein is a continuation of the program initiated under DOE contract E(10-1)-1546* entitled "Program to Design and Experimentally Test an Improved Geothermal Bit"; the program is now DOE Contract EG-76-C-1546*. The objective of the program has been to accelerate the commercial availability of a tolling cutter drill bit for geothermal applications. Data and experimental tests needed to develop a bit suited to the harsh thermal, abrasive, and chemical environment of the more problematic geothermal wells, including those drilled with air, have been obtained. Efforts were directed at the improvement of both the sealed (lubricated) and unsealed types of bits. The unsealed bit effort included determination of the rationale for materials selection, the selection of steels for the bit body, cutters, and bearings, the selection of tungsten carbide alloys for the friction bearing, and preliminary investigation of optimized tungsten carbide drilling inserts. Bits build** with the new materials were tested under stimulated wellbore conditions. The sealed bit effort provided for the evaluation of candidate high temperature seals and lubricants, utilizing two specially developed test apparatus which simulate the conditions found in a sealed bit operating in a geothermal wellbore. Phase I of the program was devoted largely to (1) the study of the geothermal environment and the failure mechanisms of existing geothermal drill bits, (2) the design and construction of separate facilities for testing both drill-bit seals and full-scale drill bits under simulated geothermal drilling conditions, and (3) fabrication of the MK-I research drill bits from high-temperature steels, and testing in the geothermal drill-bit test facility. The work accomplished in Phase I is reported in References 1 through 9. In Phase II, the first generation experimental bits were tested in the geothermal drill-bit test facility. Test results indicated that hardness retention at temperature, but not at the expense of fracture toughness, was a primary requirement for geothermal bit bearings. Materials selections for the MK-II bit were made based on these results. Also in Phase II, effort was directed at the screening of elastomers for use as a high-temperature seal for sealed bits. References 10 though 13 report the work performed in Phase II. This report summarizes the work on Phase III, encompassing the period from May 18, 1977, to May 19, 1978. There were two major tasks in Phase III which consisted of material selection, fabrication and testing of MK-III bits and Seal and lubricant evaluation. [DJE -2005].

Geopressured-geothermal Well Report. Volume I. Drilling and Completion

Geothermal Well Test Analysis

Butte County, Idaho

Support Research for Development of Improved Geothermal Drill Bits

Gulf Coast Programmatic Environmental Assessment Geothermal Well Testing

Slimhole Drilling for Geothermal Exploration

Susan 1, a hot water production well, was drilled late in 1980 for the City of Susanville, California, as part of its geothermal space-heating project. A history of drilling, logging, completion and pump testing of this well is presented. Susan 1 was drilled to 930 feet using local river water with a 17-1/2-inch bit from 50 to 540 feet and a 12-1/2-inch bit from 540 to 927 feet. A 12-3/4-inch solid casing was set from surface to 350 feet, a slotted casing from 350 to 538 feet, and a 8-5/8-inch slotted casing from 520 to 925 feet. Interpretations of the following logs and test data from this well are presented: drilling logs (penetration rate, water loss and gain, return temperatures); formation logs (description of well cuttings, caliper, spontaneous potential, electrical resistivity, gamma ray, neutron); production logs (temperature, spinner); and pump test data.

The Department of Energy (DOE) has initiated a program to evaluate the feasibility of developing the geothermal-geopressured energy resources of the Louisiana-Texas Gulf Coast. As part of this effort, DOE is contracting for the drilling of design wells to define the nature and extent of the geopressure resource. At each of several sites, one deep well (4000-6400 m) will be drilled and flow tested. One or more shallow wells will also be drilled to dispose of geopressured brines. Each site will require about 2 ha (5 acres) of land. Construction and initial flow testing will take approximately one year. If initial flow testing is successful, a continuous one-year duration flow test will take place at a rate of up to 6400 m3 (40,000 bbl) per day. Extensive tests will be conducted on the physical and chemical composition of the fluids, on their temperature and flow rate, on fluid disposal techniques, and on the reliability and performance of equipment. Each project will require a maximum of three years to complete drilling, testing, and site restoration.

This book is a detailed prognosis covering the acquisition, completion, drilling, testing and abandonment of the Frank A. Godchaux, III, Well No. 1 under the Wells of Opportunity Program. The well is located approximately 12 miles southeast of the city of Abbeville, Louisiana. Eaton Operating Company proposes to test a section of the Planulina sand at a depth ranging from 15,584 to 15,692 feet. The reservoir pressure is estimated to be 14,480 psi and the temperature of the formation water is expected to be 298 F. The water salinity is calculated to be 75,000 ppm. The well is expected to produce 20,000 barrels of water per day with a gas content of 44 *standard cubic feet pre barrel. The well was acquired from C and K Petroleu, Inc. on March 20, 1981. C and K abandoned the well at a total depth of 16,000 feet. The well has a 7-5/8 inches liner set at 13,387 feet. Eaton proposes to set 5-1/2 inch casing at 16,000 feet and produce the well through the casing using a 2-3/8 inch tubing string for wireline protection and for pressure control. A 4,600 foot saltwater disposal well will be drilled on the site and testing will be conducted similar to previous Eaton tests. The total estimated cost to perform the work is $2,959,000. An optional test from 14,905 to 15,006 feet may be performed after the original test and will require a workover with a rig on location to perform the plugback. The surface production equipment utilized on previous Eaton WOO tests will be utilized on this test. This equipment has worked satisfactorily and all parties involved in the testing are familiar with its operation. The Institute of Gas Technology and Mr. Don Clark will handle the sampling and testing and reservoir evaluation, respectively, as on the previous Eaton tests.*

Geothermal Power Plants

Geothermal Energy Update

The Frio Formation of Texas and Louisiana

Results of drilling, testing and resource confirmation. Phase II. Vale Exploratory Slimhole

Coastal Plains Geothermal Drilling and Testing Plan, Crisfield Airport No. 1 Well, Crisfield, Maryland, 1979

As a result of geopressured resource assessment studies in the Gulf Coast region, the Brazoria fairway, located in Brazoria County, Texas was determined to be an optimum area for additional studies. A plan is presented for drilling, completion, and testing of one geopressured-geothermal well and two disposal wells in Brazoria County, Texas. The objectives of the well drilling and testing program are to determine the following parameters: reservoir permeability, porosity, thickness, rock material properties, depth, temperature, and pressure; reservoir fluid content, specific gravity, resistivity, viscosity, and hydrocarbons in solution; reservoir fluid production rates, pressure, temperature, production decline, and pressure decline; geopressured well and surface equipment design requirements for high-volume production and possible sand production; specific equipment design for surface operations, hydrocarbons distribution, and effluent disposal; and possibilities of reservoir compaction and/or surface subsidence. (JGB).

This report covers the drilling and testing of the slim well 56-4 at the Reese River Geothermal Project in Lander County, Nevada. This well was partially funded through a GRED III

Cooperative Funding Agreement # DE-FC36-04GO14344, from USDOE.

This Environmental Assessment (EA) has been prepared to provide the environmental input into the Division of Geothermal Energy's decisions to expand the geothermal well testing activities to include sites in the Frio Formation of Texas and Louisiana. It is proposed that drilling rigs be leased before they are removed from sites in the formation where drilling for gas or oil exploration has been unsuccessful and that the rigs be used to complete the drilling into the geopressured zone for resource exploration. This EA addresses, on a regional basis, the expected activities, affected environment, and the possible impacts in a broad sense as they apply to the Gulf Coast well testing activity of the Geothermal Energy Geopressure Subprogram of the Department of Energy. Along the Texas and Louisiana Gulf Coast (Plate 1 and Overlay, Atlas) water at high temperatures and high pressures is trapped within Gulf basin sediments. The water is confined within or below essentially impermeable shale sequences and carries most or all of the overburden pressure. Such zones are referred to as geopressured strata. These fluids and sediments are heated to abnormally high temperatures (up to 260 C) and may provide potential reservoirs for economical production of geothermal energy. The obvious need in resource development is to assess the resource. Ongoing studies to define large-sand-volume reservoirs will ultimately define optimum sites for drilling special large diameter wells to perform large volume flow production tests. in the interim, existing well tests need to be made to help define and assess the resource.

Volume 1 Drilling and Completion, Technadril/Fenix and Scisson -- Department of Energy T/F & S -- DOE Gladys McCall No. 1 Well, Cameron Parish, Louisiana

Geopressured -- Geothermal Drilling and Testing Plan

Drilling and Testing of an Exploratory Well Truckhaven Geothermal Area Imperial County California

Geopressured-geothermal Drilling and Testing Plan. General Crude Oil--Dept. of Energy Pleasant Bayou No. 1 Well, Brazoria County, Texas

Fort Bliss Exploratory Slimholes

INEL-1 Well, Butte County, Idaho

Sandia National Laboratories manages the US Department of

Energy program for slimhole drilling. The principal objective of this program is to expand proven geothermal reserves through increased exploration, made possible by lower-cost slimhole drilling. For this to be a valid exploration method, however, it is necessary to demonstrate that slimholes yield enough data to evaluate a geothermal reservoir, and that is the focus of Sandia's current research. Sandia negotiated an agreement with Far West Capital, which operates the Steamboat Hills geothermal field, to drill and test an exploratory slimhole on their lease. The principal objectives for the slimhole were development of slimhole testing methods, comparison of slimhole data with that from adjacent production-size wells, and definition of possible higher-temperature production zones lying deeper than the existing wells.

A plan for drilling a 7500 ft exploratory hole is described. This hole would be drilled at the Idaho National Engineering Laboratory, so that it could be immediately used by one of the government facilties. The plan details the hole design, describes the drilling program, proposes a testing program, and estimates costs. (MHR).

The Hawaii Geothermal Project, a coordinated research effort of the University of Hawaii, funded by the County and State of Hawaii, and ERDA, was initiated in 1973 in an effort to identify, generate, and use geothermal energy on the Big Island of Hawaii. A number of stages are involved in developing geothermal power resources: exploration, test drilling, production testing, field development, power plant and powerline construction, and full-scale production. Phase I of the Project, which began in the summer of 1973, involved conducting exploratory surveys, developing analytical models for interpretation of geophysical results, conducting studies on energy recovery from hot brine, and examining the legal and economic implications of developing geothermal resources in the state. Phase II of the Project, initiated in the summer of 1975, centers on drilling an exploratory research well on the Island of Hawaii, but also continues operational support for the geophysical, engineering, and socioeconomic activities delineated above. The project to date is between the test drilling and production testing phase. The purpose of this assessment is to describe the activities and potential impacts associated with extensive well flow testing to be completed during

Phase II.
Development Drilling, Testing and Initial Production of the Beowawe Geothermal Field

Drilling Completion, and Testing of Geothermal Wells CD-1 and CD-2, Caliente, Nevada
Geothermal Energy Development at Pilgrim Springs, Alaska
INEL/Snake River Plain Geothermal Drilling and Testing Plan - INEL - 1 Well
Phase 2 Reese River Geothermal Project Slim Well 56-4 Drilling and Testing

During Phases 2 and 3 of the Lake City GRED II project two slim holes were cored to depths of 1728 and 4727 ft. Injection and production tests with temperature and pressure logging were performed on the OH-1 and LCSH-5 core holes. OH-1 was permanently modified by cementing an NQ tubing string in place below a depth of 947 ft. The LCSH-1a hole was drilled in Quaternary blue clay to a depth of 1727 ft and reached a temperature of 193 oF at a depth of 1649 ft. This hole failed to find evidence of a shallow geothermal system east of the Mud Volcano but the conductive temperature profile indicates temperatures near 325 oF could be present below depth of 4000 ft. The LCSH-5 hole was drilled to a depth of 4727 ft and encountered a significant shallow permeability between depths of 1443 and 1923 ft and below 3955 ft. LCSH-5 drilled impermeable Quaternary fanglomerate to a depth of 1270 ft. Below 1270 ft the rocks consist primarily of Tertiary sedimentary rocks. The most significant formation deep in LCSH-5 appears to be a series of poikoilitic mafic lava flows below a depth of 4244 ft that host the major deep permeable fracture encountered. The maximum static temperature deep in LCSH-5 is 323 oF and the maximum flowing temperature is 329 oF. This hole extended the known length of the geothermal system by 3/4 of a mile toward the north and is located over 1/2 mile north of the northernmost hot spring. The OH-1 hole was briefly flow tested prior to cementing the NQ rods in place. This flow test confirmed the zone at 947 ft is the dominant permeability in the hole. The waters produced during testing of OH-1 and LCSH-5 are generally intermediate in character between the deep geothermal water produced by the Phipps #2 well and the thermal springs. Geothermometers applied to deeper fluids tend to predict higher subsurface temperatures with the maximum being 382 oF from the Phipps #2 well. The Lake City geothermal system can be viewed as having shallow (elevation> 4000 ft and temperatures of 270 to 310 oF), intermediate (elevation 2800 to 3700 ft and temperatures 270 to 320 oF) and deep (elevations

Two geothermal test wells were drilled in January 1983, in Antelope Canyon to access the potential for resource utilization by the City of Caliente's proposed space heating district. Both holes, drilled into bedrock at 220 feet, encountered hot water in the upper part of the hole (40 to 100 feet) and *cooler water below (100 to 210 feet). A series of pumping tests were completed in February 1983, including pump-efficiency tests, stepped draw-down tests, and 1-, 2-, and 3-day sustained pumping tests. The test results indicated that the transmissivity of the thermal aquifer is very, very high. Five water samples were collected for chemical analyses during the course of CD-1 pump tests. The samples were collected to determine the water quality for the proposed space heating district and possible reinjection, and to establish a water chemistry base-line for comparative analysis of fluid chemistry during the course of the pumping and from subsequent development. 7 refs., 18 figs., 3 tabs.*

Holes GT-2 and EE-1 comprise the two deep drill holes of the Los Alamos Hot Dry Rock Geothermal Energy Extraction Experiment. EE-1 had been directionally drilled to intersect a hydraulic fracture extending outward from near the bottom of GT-2, thus completing the underground circulation loop. After the drilling of EE-1, a 16-month period of experimental testing ensued to determine the characteristics of the reservoir. This period is designated as Phase IV and includes work done in GT-2 and EE-1. As a result of this testing, it was determined that parallel fracture zones existed at the bottoms of both holes, and that the impedance to flow between the holes was too high for a meaningful flow experiment. A plan was then adopted to directionally drill out of GT-2 at a depth of about 2600 m (8500 ft) to intersect the fracture zone near the bottom of EE-1 to create a better connection. The directional drilling strategy, cementing practices, bit selections, coring procedures, and logging results comprise the Phase V work.

Phase 2 and 3 Slim Hole Drilling and Testing at the Lake City, California Geothermal Field

Geothermal Energy Geopressure Subprogram. Gulf Coast Well Testing Activity, Frio Formation, Texas and Louisiana

Testing, Planning, and Redrilling of Geothermal Test Hole GT-2, Phases IV and V. Progress Report

Final Project Report

Evaluation of a Geothermal Well Logging, DST and Pit Test

Environmental Assessment of the Hawaii Geothermal Project Well Flow Test Program

During April-May, 1995, Sandia National Laboratories, in cooperation with Trans-Pacific Geothermal Corporation, drilled a 5825' exploratory slimhole (3.85'' diameter) in the Vale Known Geothermal Resource Area (KGRA) near Vale, Oregon. This well was part of Sandia's program to evaluate slimholes as a geothermal exploration tool. During drilling we performed several temperature logs, and after drilling was complete we performed injection tests, bailing from a zone isolated by a packer, and repeated temperature logs. In addition to these measurements, the well's data set includes: 2714' of continuous core (with detailed log); daily drilling reports from Sandia and from drilling contractor personnel; daily drilling fluid records; numerous temperature logs; pressure shut-in data from injection tests; and comparative data from other wells drilled in the Vale KGRA. This report contains: (1) a narrative account of the drilling and testing, (2) a description of equipment used, (3) a brief geologic description of the formation drilled, (4) a summary

and preliminary interpretation of the data, and (5) recommendations for future work. Two geothermal test wells were drilled in January, 1983, in Antelope Canyon to access the potential for resource utilization by the City of Caliente's proposed space heating district. Both holes, drilled into bedrock at 220 feet, encountered hot water in the upper part of the hole (40 to 100 feet) and cooler water below (100 to 210 feet). Temperature-depth profiles measured in the two holes are nearly identical, and are similar to profiles measured in existing nearby wells. Lithologic logs constructed from drill chip samples reveal that a clay layer, in the vicinity of the temperature reversal, represents an aquiclude that limits fluid mixing. The diameter of well CD-l was subsequently increased from 6 inches to 14 inches to a depth of 100 feet. The well was cased with 40 feet of 8 5/8 inch diameter screen in the production zone. Well completion consisted of gravel packing, swabbing and jetting with Barafos solution to remove entrapped drilling fluids, installation of a gravel-fill tube, and cementing the upper 42 feet of the blank-cased hole. A series of pumping tests were completed in February, 1983, including pump-efficiency tests, stepped draw-down tests, and 1-, 2-, and 3-day sustained pumping tests. The test results indicated that the transmissivity of the thermal aquifer is very, very high. A pumping rate of 255 gallons per minute at 80°C (178°F) may be considered a minimum. Drawdowns of 3 to 6 feet were recovered instantly after pumping was stopped. Pumping of this well had no apparent effect on the water levels of two nearby observation wells. Significant temperature increases were recorded in both observation wells during the last few days of the tests. Five water samples were collected for chemical analyses during the course of CD-l pump tests. The samples were collected to determine the water quality for the proposed space heating district and possible reinjection, and to establish a water chemistry base-line for comparative analysis of fluid chemistry during the course of the pumping and from subsequent development. In addition, the chemical data were compared to existing analyses of thermal and non-thermal waters in Caliente. The results of these analyses indicate little or no change in composition over the period of pump testing, and demonstrate a high degree of correlation with nearby thermal fluids. The water quality meets state health standards for all chemical constituents and may be used as a source of potable water. Chemical geothermometers indicated that the maximum temperatures from this resource range from 120 to 140°C. The highest temperature measured in this resource is 96°C.

In accordance with the requirements of 10 CFR Part 711, environmental assessments are being prepared for significant activities and individual projects of the Division of Geothermal Energy (DGE) of the Energy Research and Development Administration (ERDA). This environmental assessment of geopressure well testing addresses, on a regional basis, the expected activities, affected environments, and possible impacts in a broad sense. The specific part of the program addressed by this environmental assessment is geothermal well testing by the take-over of one or more unsuccessful oil wells before the drilling rig is removed and completion of drilling into the geopressured zone. Along the Texas and Louisiana Gulf Coast (Plate 1 and Overlay) water at high temperatures and high pressures is trapped within Gulf basin sediments. The water is confined within or below essentially impermeable shale sequences and carries most or all of the overburden pressure. Such zones are referred to as geopressured strata. These fluids and sediments are heated to abnormally high temperatures (up to 260 C) and may provide potential reservoirs for economical production of geothermal energy. The obvious need in resource

development is to assess the resource. Ongoing studies to define large-sand-volume reservoirs will ultimately define optimum sites for drilling special large diameter wells to perform large volume flow production tests. In the interim, existing well tests need to be made to help define and assess the resource. The project addressed by this environmental assessment is the performance of a geothermal well test in high potential geothermal areas. Well tests involve four major actions each of which may or may not be required for each of the well tests. The four major actions are: site preparation, drilling a salt-water disposal well, actual flow testing, and abandonment of the well.

Geopressured-Geothermal Drilling and Testing Plan, Volume II, Testing Plan; Dow Chemical Co. - Dept. of Energy Dow-DOE Sweezy No. 1 Well, Vermilion Parish, Louisiana

Geopressured-geothermal Drilling and Testing Plan General Crude Oil - Dept. of Energy Pleasant Bayou No. 2 Well Brazoria County, Texas

Geothermal Reservoir Engineering

Drilling and Testing

Drilling, Completion, and Testing of Geothermal Wells CD-1 and CD-2, Caliente, Nevada

The Beowawe geothermal field in north central Nevada is generating 16MW using two production wells (Ginn 1-13 and 2-13) and one injection well (Batz). Drilling the second production well (Chevron Ginn 2-13) in 1985 led to the discovery of a second productive strand of the Malpais fault zone. The wells are completed in the Malpais fault zone and are capable of producing 420+°F geothermal fluid at rates exceeding 1,000,000 lbs/hr. Initial testing suggests that the completion zones of the two production wells have no pressure communication, therefore providing what is essentially a second production zone for future development. Injection of produced fluids into a fault parallel with the Malpais shows no pressure communication with other wells. One year of production in the system shows no pressure depletion or enthalpy decline in the producing area. 1 tab., 6 figs., 5 refs.

Maurer Engineering developed special high-temperature geothermal turbodrills for LANL in the 1970s to overcome motor temperature limitations. These turbodrills were used to drill the directional portions of LANL's Hot Dry Rock Geothermal Wells at Fenton Hill, New Mexico. The Hot Dry Rock concept is to drill parallel inclined wells (35-degree inclination), hydraulically fracture between these wells, and then circulate cold water down one well and through the fractures and produce hot water out of the second well. At the time LANL drilled the Fenton Hill wells, the LANL turbodrill was the only motor in the world that would drill at the high temperatures encountered in these wells. It was difficult to operate the turbodrills continuously at low speed due to the low torque output of the LANL turbodrills. The turbodrills would stall frequently and could only be restarted by lifting the bit off bottom. This allowed the bit to rotate at very high speeds, and as a result, there was excessive wear in the bearings and on the gauge of insert roller bits due to these high rotary speeds. In 1998, Maurer Engineering developed an Advanced Geothermal Turbodrill (AGT) for the National Advanced Drilling and Excavation Technology (NADET) at MIT by adding a planetary speed reducer to the LANL turbodrill to increase its torque and reduce its rotary speed. Drilling tests were conducted with the AGT using 12 1/2-inch insert roller bits in Texas Pink Granite. The drilling tests were very successful, with the AGT drilling 94 ft/hr in Texas Pink Granite compared to 45 ft/hr with the LANL turbodrill and 42 ft/hr with a rotary drill. Field tests are currently being planned in Mexico and in geothermal wells in California to demonstrate the ability of the AGT to increase drilling rates and reduce drilling costs.