Proceedings World Geothermal Congress 2000
Kyushu - Tohoku, Japan, May 28 - June 10, 2000

UTILITY OF THE DATA GATHERED FROM THE FENTON HILL PROJECT FOR DEVELOPMENT OF ENHANCED GEOTHERMAL SYSTEMS

Ann Robertson-Tait[1], Christopher Klein[1] and Lynn McLarty[2]
[1]GeothermEx, Inc., 5221 Central Avenue, Suite 201, Richmond, California 94804-5829 USA
[2]Princeton Energy Resources International, 1700 Rockville Pike, Suite 550, Rockville, Maryland 20852 USA

Key Words: EGS, HDR, Hot Dry Rock, data archive

ABSTRACT

To prioritize information for archiving and to determine the applicability of the Fenton Hill experience to the future development of Enhanced Geothermal Systems (EGS), an integrated review was made of five categories of Fenton Hill information: hydraulic fracturing data, well logs, seismic data, flow test data and tracer test data. Major experiments were identified, the methods of data collection and analysis were determined, the location and format of the data were determined, and further analyses that would yield information of value to EGS developers were suggested. Such analyses would be directed toward the determination of: 1) if and how the state of stress in the reservoir changed during sequential fracturing jobs; 2) how the orientation of fractures changed with depth and location; 3) how the reservoir size increased as fracturing and flow testing operations proceeded; 4) how the hydraulic properties and heat-transfer characteristics of the reservoir varied with changes in operating conditions; and 5) how the Phase II reservoir (the deeper and hotter of the two reservoirs developed) would behave over the long term under various operating conditions.

By archiving and analyzing certain data, the Fenton Hill experience could be used to guide effective hydraulic fracturing operations, collection of seismic data for reservoir mapping, and well logging programs. A numerical model of the Fenton Hill system, derived from a carefully considered conceptual model of the reservoir and fully calibrated against existing test data, could be used to develop guidelines for optimizing production from an EGS reservoir using various production/injection schemes. These types of evaluations would necessarily integrate all five categories of data mentioned above to extract information relevant to EGS reservoir behavior, particularly for systems developed in crystalline rock. In this way, the resolution of important unanswered question about the nature of the Fenton Hill system could be used to reduce the cost and improve the success rate of EGS development elsewhere.

1. INTRODUCTION

Numerous scientific and engineering experiments produced a vast amount of data during the course of the Fenton Hill Hot Dry Rock project, which spanned more than 20 years. After reviewing the Fenton Hill experience to identify the techniques developed and the major experiments undertaken (GeothermEx, 1999a), the location and format of data sets generated from these experiments were determined, and an evaluation of the utility of the Fenton Hill data for the future development of EGS was undertaken. Approximately three man-months of effort were budgeted for each of the two Fenton Hill studies (project review and data assessment). Considering the magnitude of the Fenton Hill HDR project, this work was not intended to be a comprehensive. Instead, we focused on those aspects most likely to be of benefit to developers of EGS in the near term, thus prioritizing information for indexing and archiving. Such an archive would enable the Fenton Hill experience to be leveraged for the development of other Enhance Geothermal Systems.

2. OVERVIEW OF FENTON HILL

Phase I and Phase II refer to the two phases of reservoir development at Fenton Hill. In Phase I, a circulation system was developed between wells EE-1 (injector) and GT-2B (producer) at approximately 2,700 to 3,000 m. In Phase II, a deeper circulation system was developed at approximately 3,500 m between wells EE-3A (injector) and EE-2 (producer) and later between EE-3A (injector) and EE-2A (producer). Well locations are shown in Figure 1, and the major experiments undertaken are listed in Tables 1 and 2.

2.1 Phase I

In Phase I, it was determined that fractures could be artificially created by hydraulically stimulating wells drilled in hot, deep intrusive rock, and that pressurization, hydraulic fracturing, heat extraction and consequent thermal contraction all caused increases in reservoir volume. Newly developed tracer techniques indicated that the volume of the most direct paths through the system was approximately 80% of the total volume of the system, and the volume of the reservoir that was active in terms of heat transfer and fluid flow was a portion of a larger fracture system. Passive microseismic techniques were developed and used to map the reservoir. Seismic events observed during initial pressurization of the first reservoir created during Phase I were clustered about a vertical plane whose strike remained remarkably constant, while continued pressurization and water-loss diffusion resulted in a general displacement of microseismic events in a more dispersed region extending more than 450 m away from both the injection point and the initial locus of events. Seismic data suggested that the second reservoir created during Phase I was not planar, but highly jointed and multiply fractured, indicating a volumetric rather than an areal source of heat, which was also observed in the deeper Phase II reservoir.

2.2 Phase II

In Phase II, hydraulic fracturing created a network of many small fractures. It was realized that the fracture system could be extended by injecting greater volumes of water; this led to the Massive Hydraulic Fracturing operations. The Phase II reservoir system was comprised of natural, pre-existing joints that were opened and propped by fluid pressure; the contemporary stress field dictated the conditions under which these joints opened upon pressurization. In contrast to the Phase I “First Reservoir,” tracer testing indicated that the most direct flow paths comprised about 30% of the reservoir volume. Downhole temperature and tracer data both suggested that the flow through the reservoir progressively shifted towards a greater number of indirect flow paths as testing proceeded, rather than becoming concentrated into a few direct flow paths. Considerable improvements were made in seismic data collection, which led not only to more accurate locations of seismic events, but also to additional analyses that led to better understanding of the reservoir and its connections to the wells.

3. REVIEW OF FENTON HILL DATA

For this work, we evaluated the data from: 1) hydraulic fracturing operations; 2) seismic mapping of hydraulically induced fractures; 3) flow tests; 4) tracer tests; and 5) well logs. Tables 1 and 2 list the experiments of interest from which such data were generated. Information on data location and the format in included in the Fenton Hill Data Review (GeothermEx, 1999b).

3.1 Hydraulic Fracturing Data

Hydraulic fracturing was the means used to create the Fenton Hill HDR system, and future EGS experimentation in low-permeability reservoirs will involve similar stimulations. The data collected during hydraulic fracturing or other well pressurization experiments at Fenton Hill typically included: wellhead temperature and pressure of the stimulated well; injection rate; annulus pressure; and in some cases, pressure, temperature and flow rate data from observation wells. A review of these data, undertaken by specialists in hydraulic fracturing and rock mechanics, could be combined with evaluations of seismic results and well log data to answer certain relevant questions. These include if and how the state of stress changed during sequential fracturing jobs, how the orientation of fractures changed with depth and location, and how the reservoir size increased as operations proceeded. This work would allow a more complete understanding of the details of the Fenton Hill stimulations (injection rates and pressures, fractured volumes, fracture orientations, etc.). Ideally, a database including the Fenton Hill and other well stimulations would be developed that summarizes the procedures followed and the results obtained.

3.2 Seismic Data

Raw data of interest include information on station locations, tools; calibration shots; and the actual waveforms collected. Interpreted data of interest include seismic velocity structure, hypocentral locations (and the estimated range of error therein), features identified from statistical or other analyses, information on source mechanisms, and analyses of long-period events that have been identified in some data sets.

It appears warranted that some effort be made to organize, catalog and store the existing data in a single location and format, and on media that are likely to have long-term stability. Given the mixed opinions about the quality and value of further analysis of Phase I seismic data, this work for Phase I may best be restricted to the data from Experiments 203, 195 and 204 (hydraulic fracturing and flow testing of well EE-1) and the Stress Unlocking Experiment at the end of Run Segment 5 (Experiment 217). The data from these experiments are important enough and of suitable quality to merit re-evaluation using newer techniques.

For Phase II, there is a very great quantity of digital data on disks, analog tape and digital tape, and an effort to store and catalog all of the raw data may exceed patience and reasonable expense. Any further analysis of seismic data should be part of an integrated evaluation of all five categories discussed herein to investigate fundamental EGS reservoir concepts that may apply at other sites. Considering the cost and effort required, only the data needed for such an effort should be obtained, processed and archived. Furthermore, limitations on data quality and certainty, including the instrument location with respect to basement, calibration techniques, and instrument quality and behavior would need to be considered. In this regard, the hands-on experience of LANL personnel has been crucial to the existing data processing, and much of this experience may not be clearly documented along with the raw data and even with much of the processed data. Therefore, the cataloging effort would need to involve the original LANL seismologists, to document these limitations and how they have been handled.

The eventual goal of cataloging and storing the seismic data would be to test the existing data with newer techniques of numerical analysis, and to integrate the results of all experiments to trace the history of reservoir development, approaching the project from a single, consistent point of view. Of particular but not exclusive interest would be: a) an evaluation of long-period events, which were identified after extensive filtering of the data from Experiment 2032; b) review of the hypocentral location data from sequential fracturing jobs conducted in EE-2 and EE-3A with a view toward analyzing the growth of the reservoir; and c) the breakdown behavior of the rock and the growth of the reservoir analyzed using a combination of hydraulic fracturing and seismic studies.

Because several members of the LANL Fenton Hill project staff are participants in EGS seismology projects such as the "More Than Cloud" and "Post-More Than Cloud" projects, the activities of these projects, and perhaps others, should be reviewed fully before any additional evaluation of the Fenton Hill data is contemplated, to avoid duplication of effort.

3.3 Flow Test Data

Further evaluations of the Fenton Hill flow test data should be undertaken to better understand the size of the reservoir, its hydraulic properties and heat-transfer characteristics under various operating conditions, particularly by use of numerical simulation, which could project long-term behavior and the potential of enhancing production with additional production wells. The results of such analyses would have obvious implications for other developers of EGS. Limitations on modeling of Phase II data are set, however, by the lack of true long-term flow and temperature drawdown during the Phase II tests.

A relatively thorough Phase I flow test analysis has been made in terms of temperature behavior and system impedance, but the physical model of the Phase I reservoir was never brought to complete consensus, and the evidence for reservoir growth during the test was somewhat model-specific. This important conclusion should be re-investigated with an integrated analysis that includes evaluation of transient pressure data (not yet fully studied) and a new numerical model.

In contrast, the physical model of the Phase II reservoir is in some ways better understood (from seismic data), but there was very little in-depth analysis of the Phase II test data. Some of this evaluation is being done by interested parties outside LANL, particularly to validate numerical models of

HDR systems. Data from the 1992-1993 Long Term Flow Test (LTFT) and the 1995 Reservoir Verification Flow Test (RVFT) have recently been extracted from the proprietary data collection system used at Fenton Hill; this is an important first step.

There is more to be gained from an integrated look at the Phase II system, which, given convenient data access, should include further study of:

- Pressure transient data and long-term leak-off data with respect to the opening pressures of joints (a focus of past investigations).
- LANL's conclusion that flow became more dispersed through a growing fracture network with time.
- The pressure-dependency of reservoir storage and other hydraulic properties.
- The cyclic flow tests that were conducted at the end of Phase II (May 1993) and during the RVFT, that produced encouraging results in terms of energy recovery. As far as we know, these tests have not been evaluated in terms of reservoir engineering and rock mechanics, and the apparent significance of the results should be evaluated in light of these disciplines.
- Numerical modeling to estimate the additional energy recovery that can be expected from having more than one production well per injection well (LANL has done some preliminary work on this). Similarly, a coupled wellbore-reservoir model could be developed to evaluate energy production and well behavior (particularly wellbore heat loss) at various operating pressures and flow rates. For these types of studies, well test data would be used to calibrate a model of the reservoir, thus enabling predictions of future performance to be made under various operating scenarios.
- It has been inferred that a connection was made between the Phase I and Phase II reservoirs at Fenton Hill, either through the reservoir or via the annulus of the injection well. A further evaluation of observation well data and other data (seismic, tracer and well log) may confirm the connection. If so, the mechanism of connection should be evaluated.
- Returns of water to the surface through the annulus were consistently observed during Phase II testing, particularly at higher pressures of injection and production. The origins of these leaks were not well understood, and their potential long-term consequences not known. Because such leaks present the risk of long-term well degradation, and because they reduce production efficiency, they should be more thoroughly evaluated.

The "MURPHY" (Multi-disciplinary Understanding of Reservoir Physics) project is underway to evaluate flow test and other data from EGS reservoirs. Several individuals presently or formerly with LANL are involved in this. Therefore, it is possible that additional evaluation of Fenton Hill test data is being or will be undertaken under the auspices of that program, and duplication of effort should obviously be avoided.

3.4 Tracer Test Data

Tracer tests are relatively inexpensive to implement and evaluate, and so can provide good value for cost. A relatively thorough analysis has been made of most of the Phase I data, which include evidence of "growth" during a flow test that included five tracer tests. This important result should be investigated further by combining an analysis of stress field and fracture characterization information, flow test data, tracer test data and seismic data.

The tracer tests of the Phase II reservoir have not been fully evaluated, particularly those from the tests during and after the first phase of the LTFT. Tracer test analysis should be used in a full evaluation of the Phase II reservoir and its possible connection with the shallower, Phase I reservoir. Although some numerical modeling of the Phase II reservoir has been done (mostly using the Geocrack2D simulator), tracer test results may serve to calibrate a more advanced model with the ultimate goal of theoretically optimizing production and injection in a Fenton Hill-type system. There will be limitations to tracer-based calibrations because the system geometry can never be uniquely established, and long-term tracer return data are generally not available (tests were often terminated before tracer levels had stabilized).

Furthermore, an effort should be made to determine if tracer test data can be used to confirm or refute concepts about the evolution of the Phase II reservoir as it was being tested. As mentioned above, it has been proposed that flow became more dispersed through a greater number of paths as testing proceeded, suggesting a "self-regulating" mechanism which would make short-circuiting unlikely. If true, this is extremely positive news for the future of the EGS program. Confirmation of this concept would be important to future developers of EGS, and further evaluation of tracer test data and results would be useful to that end.

3.5 Well Log Data

Evaluation of well log data may be needed to support revisions to the conceptual models of the Phase I and Phase II reservoirs that are discussed above. If so, developing a full set of geologic logs for the four wells of interest (GT-2B, EE-1, EE-2A and EE-3A) would be a useful starting point. This work has been partially completed by LANL. Further interpretation of temperature logs may also assist the development of a coupled wellbore and reservoir model, which would be useful for simulations of energy recovery at various operating pressures.

Shortcomings in standard types of logs and/or tools for problems specific to the development and assessment of EGS could be identified from a detailed evaluation of the Fenton Hill logs. For example, although the overall flow rate and temperature of a producing interval can be determined, temperature and spinner logs may be too imprecise and the interval of measurement too coarse to identify individual fractures. Gamma ray tools may need similar modification to enable precise measurements of radioactive tracer returns. The desired levels of precision should be evaluated in light of existing experience, and then reviewed by expert(s) on well logging technology, to determine whether improvements are likely to be achieved.

4. DISCUSSION

Without an archive of a portion of the Fenton Hill data, it would be very difficult to make any sort of integrated analysis, which is required to extract information relevant to EGS reservoir behavior in general, and particularly for systems developed in crystalline rock. However, difficulties will be encountered in obtaining and storing the data (particularly the seismic data), which will likely result in an incomplete archive. A very strong commitment to the data retrieval process, necessarily involving LANL personnel, would be needed to completely archive the data of interest from Fenton Hill, thus preserving it for additional evaluation.

Further studies of the Fenton Hill Project data should be carried out in the context of answering two general questions that relate to hypothetical future EGS projects in low permeability reservoirs. The objectives of such projects would be relatively simple: to drill into hot but (relatively) impermeable rock, fracture the rock to achieve hydraulic communication between wells, and produce energy at the surface at commercially viable rates.

The first question that follows is: what part of the Fenton Hill data and experience could be used to reduce the cost of EGS development in a low-permeability reservoir? In such a development, a tight well would be hydraulically fractured and the fractures would be mapped using seismic techniques. This leads to asking: a) given the history of hydraulic fracturing, is there a relatively simple set of fracturing operations that is most likely to be successful; b) what are the required operations (*i.e.*, fracturing equipment, pressures, fluid rates and volumes, and well completions); and c) what is the minimum seismic array needed, how should data be collected, and what analyses of seismic data will yield the required definition? If downhole geophones are essential, the drilling and emplacement cost will not be insignificant unless wells of opportunity are available.

It follows that the Fenton Hill hydraulic fracturing and seismic data should be reviewed to extract a set of experiences that would serve as type examples for future operations, showing how the results of these experiences can be evaluated, showing how they relate to planning and executing a cost-effective project, and illustrating risks and uncertainties.

The second question that follows is: what unresolved questions could be partially or fully resolved by further evaluation of the Fenton Hill data? This leads to asking questions related to long-term energy recovery from the system: a) what would the temperature drawdown have been during long-term flow; b) would cyclic production schemes enhance long-term energy recovery, and; c) would multiple production wells tied to a single injector produce higher overall energy production efficiency?

These questions can only be resolved by numerically modeling the existing data with an appropriate numerical simulator, fully calibrated against existing test data. Although such models would undoubtedly include a fair amount of conjecture, they should at least be able to define the limits to development, and the results would suggest various methods of optimizing production under a given set of operational constraints.

ACKNOWLEDGEMENTS

This work was supported by the United States Department of Energy. The authors acknowledge with gratitude the helpful attitude of the LANL personnel interviewed for this effort. We also solicited opinions from U.S. geothermal developers, and discussed the relevance of the techniques and data resulting from the Fenton Hill project with foreign developers of EGS, and the academic researchers who undertake technical analyses of such projects. These opinions provided a valuable addition to this assessment.

REFERENCES

GeothermEx, 1999a. Peer Review of the Hot Dry Rock Project at Fenton Hill, New Mexico. Report prepared for the U.S. Department of Energy (includes a comprehensive list of Fenton Hill references used, which are too numerous to include here).

GeothermEx, 1999b. Data Review of the Hot Dry Rock Project at Fenton Hill, New Mexico. Report prepared for the U.S. Department of Energy.

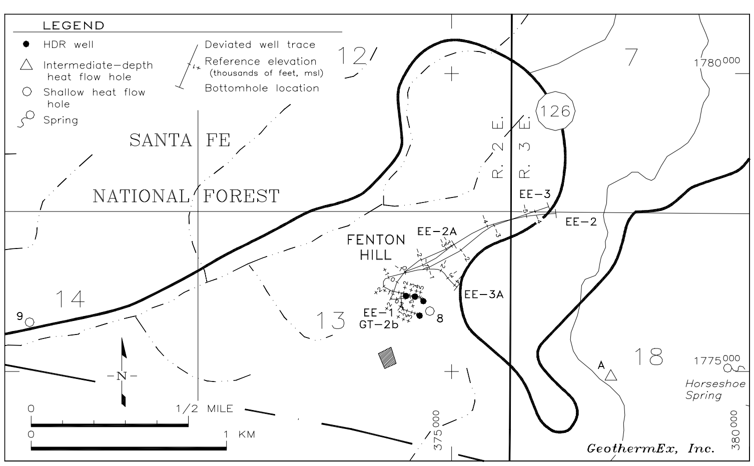

Figure 1: Well locations at Fenton Hill

Table 1: Summary of Important Phase I Experiments at Fenton Hill

Well (s)	Date	Exp. No.	Description of Operation
GT-1	Mar 73	- -	Hydraulic fracturing between 740 and 776m
GT-2 (TD 1,936m)	Aug - Sep 74	- -	Hydraulic fracturing in three intervals
GT-2 (TD 2,042m)	Oct 74	- -	Hydraulic fracturing through PBR and cemented liner
GT-2 (TD 2,042m)	Oct 74	- -	Hydraulic fracturing through perforations in cemented liner
GT-2 (TD 2,932m)	Dec 74?	- -	Injection fall-off test in deepened well
GT-2 (TD 2,932m)	Jul - Aug 75	- -	Hydraulic fracturing through perforations at 2,789 - 2,911m
EE-1 (TD 2,099m)	Aug 75	- -	Hydraulic fracturing
GT-2 + EE-1 (TD 2,099m)	Aug 75	- -	SP and IP logs in EE-1 and GT-2
EE-1 (TD 2,099m)	Aug 75	- -	Acoustic ranging experiment
EE-1 (TD 2,774m)	1 Sep 75	- -	Acoustic ranging experiment
EE-1 (TD 2,919m)	Sep 75	- -	Acoustic ranging experiment
EE-1 (TD 2,919m)	Sep 75	- -	Repeat of acoustic ranging experiment
GT-2	20 Sep 75	- -	Extension of fracture in GT-2
EE-1 (TD 2,919m?)	20 Sep 75	- -	SP and IP logs in EE-1 while extending fracture in GT-2
EE-1 (TD 3,011m)	30 Sep 75	- -	Pressurization of GT-2 and recording seismicity in EE-1
EE-1 (TD 3,011m)	5 Oct 75	- -	Pressurization of GT-2 and recording seismicity in EE-1
EE-1 (TD 3,064m)	14 Oct 75	- -	Hydraulic fracturing below open hole packer at 2,926m
GT-2 + EE-1 (TD 3,064m)	3 - 5 Mar 76	117	Injecting into EE-1 and recording seismicity in GT-2
GT-2 and EE-1	23 and 24 Mar 76	115	Tracer test using Na-F (sodium fluorescein)
GT-2 and EE-1	6 May 76	122	Injecting into EE-1 gpm and recording seismicity in GT-2
GT-2 and EE-1	27 May 76	126	"Wallbanger" generated signals in EE-1 (recorded in GT-2)
GT-2 and EE-1	16 Jun 76	127	Wallbanger generated signals in EE-2 (recorded in GT-2)
GT-2 and EE-1	22 - 29 Jun 76	129A; 129B	Fracture mapping while injecting in EE-1
GT-2 and EE-1	14 Oct 76	145	Acoustic ranging experiment
GT-2 and EE-1	27 Oct 76	146	Acoustic ranging experiment
GT-2 and EE-1	1 - 11 Nov 1976	137	Flow and tracer test of Phase I "First Reservoir"
GT-2 and EE-1	12 - 13 Jan 77	150	Acoustic ranging experiment
GT-2 and EE-1	8 Mar 77	159	Shear-shadowing experiment
GT-2 and EE-1	9 Mar 77	159B	Repeat of shear-shadowing experiment
GT-2 and EE-1	16 Mar 77	160	Induced-potential log from 2,256 - 2,774m in GT-2
GT-2 and EE-1	21 Mar 77	159C	Repeat of shear-shadowing experiment
GT-2 and EE-1	22 Mar 77	159D	Repeat of shear-shadowing
GT-2B (TD 2,672m)	1 - 3 Jun 77	166	Hydraulic fracturing with open hole packer at 2,654m
EE-1 + GT-2B (TD 2,672m)	16 Jun 77	170	12 hours of injection into EE-1 and production from GT-2B
EE-1 + GT-2B (TD 2,715m)	8 Aug 77	172A	Step-pressurization of EE-1 with GT-2B shut in
EE-1 + GT-2B (TD 2,715m)	18 Aug 77	172C	Step-pressurization of GT-2B with EE-1 shut in
EE-1 and GT-2B	26 - 30 Sep 77	176	Run Segment 1 - four day flow test
EE-1 and GT-2B	26 - 28 Oct 77	174	Acoustic attenuation (shear-shadowing) experiment
EE-1 and GT-2B	28 Jan - 13 Apr 78	176	Run Segment 2 (injection into EE-1 and production from GT-2B)
EE-1 and GT-2B	8 - 13 Sep 78	185	Acoustic attenuation (shear-shadowing) experiment
EE-1 and GT-2B	18 Sep - 16 Oct 78	186	Run Segment 3 (high back-pressure experiment) - 28 day test
EE-1 and GT-2B	23 - 27 Oct 78	190	Low back-pressure impedance measurement after experiment 186
EE-1	14 Mar 79	203	"High flow/high pressure" test of EE-1 (hydraulic fracturing)
EE-1	21 Mar 79	195	Massive hydraulic fracturing of EE-1
EE-1 and GT-2B	22 Mar 79	204	Post-MHF flow test
EE-1 and GT-2B	23 Oct - 15 Nov 79	215	Run Segment 4 (injection into EE-1 and production from GT-2B)
EE-1 and GT-2B	27 Feb - 8 Dec 80	217	Run Segment 5 (low back-pressure test)
EE-1 and GT-2B	9 - 10 Dec 80	217?	Stress Unlocking Experiment (SUE)
EE-1 and GT-2B	11 - 16 Dec 80	217?	Post - SUE flow test

Table 2: Summary of Important Phase II Experiments at Fenton Hill

Well (s)	Date	Exp. No.	Description of Operation
EE-2	6 Jan 82	2003	Open hole (no zone isolation) injection test - 2-1/2 hours
EE-3	19 Jan 82	2006	Open hole (no zone isolation) injection test - 6 hours
EE-3	27 Feb 82	2007	Open hole (no zone isolation) injection test - 6 hours
EE-2	30 May 82	2011	Hydraulic fracturing of EE-2
EE-2	4 - 5 Jun 82	2012	Hydraulic fracturing of EE-2
EE-2	19 - 20 Jun 82	2016	Hydraulic fracturing of EE-2
EE-2	19 - 20 Jul 82	2018	Hydraulic fracturing of EE-2
EE-2	24 Jul 82	2019	Hydraulic fracturing of EE-2
EE-2	6 - 7 Oct 82	2020	Hydraulic fracturing of EE-2
EE-3	8 Nov 82	2023	Open hole (no zone isolation) injection test - 6 hours
EE-3	13 - 14 Dec 82	2025	Hydraulic fracturing of EE-3
EE-3	27 Sep 83	2033	Hydraulic fracturing of EE-3
EE-2	6 - 9 Dec 83	2032	Massive Hydraulic Fracturing in EE-2
EE-3	31 Jan 84; 4 - 5 May 84	2037, 2039	Investigation of "seismically quiet" region around EE-3
EE-3	15 - 19 May 84	2042	Massive Hydraulic Fracturing in EE-3
EE-3	after Dec 84	2043, 2044	Temperature/gamma ray logging to study fractures in EE-3
- -	7 Aug 84	2048	Calibration shot to determine station corrections
EE-2	16 Apr - 1 May 85	2052	Hydraulic fracturing of EE-2 (3,528 - 3,550m)
EE-2+EE-3A (TD 3,720m)	27 - 28 May 1985	2059	Hydraulic fracturing below open-hole packer at 3,505m
EE-3A (TD 4,018m)	29 Jun - 2 Jul 85	2061	Hydraulic fracturing below open-hole packer at 3,830m
EE-3A (TD 4,018m)	18 - 20 Jul 85	2062	Hydraulic fracturing below open-hole packer at 3,650m
EE-3A (TD 4,018m)		2063	Hydraulic fracturing
EE-3A (TD 4,018m)	30 Jan - 2 Feb 86	2066	Hydraulic fracturing below open-hole packer at 3,760m
EE-2+EE-3A (TD 4,018m)	19 May - 18 Jun 1986	2067	Initial Closed-Loop Flow Test (ICFT) of EE-2 / EE-3A system
EE-2	24 Sep - 9 Nov 86	2068	Venting of EE-2 after ICFT
EE-3A	5 - 6 Dec 86	2070	Injection into EE-3A to evaluate post-ICFT pressures
- -	Jan 87 on	2032, 2061, 2066, 2067	Re-analysis of seismic data -transfer from analog tapes to MASSCOMP system
EE-2A / EE-3A	2 - 9 Dec 87	2074	Six-day flow test
EE-2A	15 Jun 88	2076	Injection test in EE-2A to test liner/tie-back integrity
EE-3A	91	2077	Reservoir "leak-off" tests
EE-2A / EE-3A	Dec 91; Feb 92; Mar 92	- -	Four "preliminary" tests of Phase II system
EE-2A / EE-3A	8 Apr - 31 Jul 92	- -	First Phase of Long Term Flow Test (LTFT)
EE-2A / EE-3A	20 Aug - 1 Oct 92	- -	Interim Flow Test
EE-2A / EE-3A	4 - 16 Dec 92	- -	1.24 MPa (1,800 psi) back-pressure test
EE-2A / EE-3A	18 Dec 92 - 3 Jan 93	- -	1.52 MPa (2,200 psi) back pressure test
EE-2A / EE-3A	22 Feb - 17 Apr 93	- -	Second Phase of Long Term Flow Test
EE-2A / EE-3A	4 - 6 May 93	- -	Cyclic flow tests
EE-2A / EE-3A	?? - 18 May 93	- -	Post-cyclic flow
EE-2A / EE-3A	18 May 93 - May 95	- -	Long term pressure and temperature monitoring
EE-2A / EE-3A	10 May - 13 Jun 95	- -	First Phase of Reservoir Verification Flow Test (RVFT)
EE-2A / EE-3A	14 - 29 Jun 95	- -	Second Phase of Reservoir Verification Flow Test (RVFT)
EE-2A / EE-3A	3 - 9 Jul 95	- -	Load-following experiment
EE-2A / EE-3A	11 Jul 95	- -	Tracer tests