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UNITED STATES GULF COAST GEOPRESSURED
GEOTHERMAL PROGRAM. SPECIAL PROJECTS
RESEARCH AND COORDINATION ASSISTANCE

Final Report, October 1, 1977—November 30, 1978

By
Myron H. Dorfman
D. G. Bebout

April 1979

Work Performed Under Contract No. EY-76-S-05-5243

Center for Energy Studies and
Bureau of Economic Geology
The University of Texas
Austin, Texas

U. S. DEPARTMENT OF ENERGY
Geothermal Energy

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United States Gulf Coast Geopressured Geothermal Program
Special Projects Research and Coordination Assistance

Final Report for the Period
1 October 1977 - 30 November 1978

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INTRODUCTION

The United States Gulf Coast Geopressured Geothermal Program Special Projects Research and Coordination Assistance contract calls for the Center for Energy Studies and the Bureau of Economic Geology at UT Austin to assist DOE/DGE in the orderly development of the potential Geopressured Geothermal resource in the Gulf Coast region.

In general, this coordination assistance function takes the form of providing liaison with various industrial components that participate in the program and with state and local agencies.

This document contains a report of the activities of the UT research group in the areas of Coordination and Assistance as performed under this contract. The material is grouped by activities as described in the proposal from which the contract was generated.

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ACTIVITIES

1. PROJECT TECHNICAL COORDINATION ASSISTANCE AND LIAISON

Task 1

Subtask 1

The Geothermal Board of Advisors, consisting of representatives of industrial groups, state and local agencies, and research participants was maintained. The members of the Board of Advisors are listed in Appendix A. This board met in November 1977 at Lafayette, Louisiana and on 7 July 1978 in Houston, Texas at the Houston Lighting and Power Building prior to the dedication ceremony for the DOE/GCO geopressured test well.

The general function of this advisory board is to provide for a pragmatic evaluation of the research program and to promote industrial participation in the development of the Gulf Coast geopressured resource.

Subtasks 2 and 3

Technically qualified staff members attended technical meetings and presented technical papers and gave speeches to governmental, and civic organizations throughout the term of the contract. A summary of the staff members participation in this activity is included in this report.

Subtask 4

A report of meetings attended and talks given is attached in Appendix B together with representative evaluations of such talks.

Subtask 5

A summary of the record of meetings attended and talks presented in Subtask 3 is attached in Appendix B.

2. TECHNICAL ASSISTANCE FOR REVIEW AND EVALUATION OF PROPOSALS AND CONTRACT RESULTS

Task 1

According to our files, no requests for this type of assistance were made by DOE during this reporting period for:

Subtask 1 Provide technical assistance and advice on scope-of-work statements; and

Subtask 2 Provide technical assistance in preparing Program Research and Development Announcements.

Subtask 3

Provided technical assistance in reviewing and evaluating proposals. Qualified staff members have reviewed at least 14 papers and proposals during the period 10/1/77 to 11/30/78.

Subtask 4

Provided technical assistance in reviewing and evaluating technical contract results. Our records show the following reports were reviewed and evaluated:

Doscher, Todd M. Economics of Producing Methane (Exclusively) from Geopressured Aquifers along the Gulf Coast. Petroleum Engineering Department, University of Southern California, October 15, 1977, p. 61.

Geopressured-Geothermal Drilling and Testing Plan. General Crude Oil-Department of Energy, Pleasant Bayou No. 1 Well, Brazoria County, Texas, May 1978.

Kouskraa, V. A. Economic Potential of Domestic Geopressure Aquifers. Lewin & Associates, Inc., December 1977.

3. TECHNICAL ASSISTANCE AND COORDINATION FOR GEOPRESSURE GEOTHERMAL TEST WELLS

Task 1

The Center for Energy Studies provided personnel for technical assistance in the planning of the test well, the manner of collecting data obtained during drilling, evaluation of the data, and for completion and production testing.

Subtask 1

Initial plans for drilling the Pleasant Bayou No. 1 test well near Chocolate Bayou in Brazoria County, Texas, were completed in 1977. The proposed location was selected by geologists of the Bureau of Economic Geology, The University of Texas at Austin. The proposed drilling plan was developed by General Crude Oil personnel, generally conforming to the final plan, Geopressured-Geothermal Drilling and Testing Plan, published by the Department of Energy. The proposed plan was reviewed and approved by Dr. M. H. Dorfman, Dr. A. L. Podio, and W. E. Boyd of The University of Texas. These plans were essentially complete by October 1977, but final approval by DOE was not obtained until February 1978 at a meeting of personnel for DOE, General Crude Oil, and The University of Texas personnel. W. E. Boyd coordinated this meeting at which general concurrence was obtained for the final plan, as above. Following this meeting the field contractor, General Crude Oil Company, initiated inquiry for a suitable contract drilling rig, and selected Welsh Drilling and Service Company to provide a new outfit, designated Rig 15, that was scheduled to be assembled during April and May. Delivery of rig components delayed the work of putting the unit together about thirty days. Preparation of the location at Chocolate Bayou was completed

in June, the rig moved in and rigging up completed by the end of the month. The well was spudded on June 30, 1978. The attached Drilling Report, "GCO-DOE Pleasant Bayou No. 1," Appendix C, shows daily progress after that date.

W. E. Boyd made a report on the proposed drilling plan for the test well to an industry review committee, convened in Dallas by the Department of Energy, September 22, 1977. Dr. M. H. Dorfman and other personnel of the Center for Energy Studies also spoke at that meeting. Three other meetings of this group were held as follows:

Houston	November 3, 1977
Lafayette	November 16, 1977
Houston	December 21, 1977

At these meetings, specific plans for drilling the test well in Brazoria County were reviewed, discussed, and categorically approved. M. H. Dorfman, W. E. Boyd, D. G. Bebout, R. G. Loucks, and A. R. Gregory presented the views of The University of Texas. Agreement was obtained on logging, coring, and casing procedures.

M. H. Dorfman, W. E. Boyd, A. W. Oberbeck, D. G. Bebout, R. G. Loucks, K. E. Gray, and others of The University of Texas, participated in the Third Geopressured Conference held at Lafayette, Louisiana, November 16-18, 1977. W. E. Boyd presented a paper entitled, "Drilling and Completion Plans for a Geopressured Well," which described in detail the proposed program for the test well. An abstract of that paper is attached, Appendix D. At this meeting, DOE personnel met with General Crude Oil people and The University of Texas geologists, to agree on plans for environmental studies and base-line information that would be needed for the specific well site prior to drilling. T. C. Gustavson and others of the Bureau of Economic Geology were contracted by DOE to

make the environmental studies. Center for Energy Studies personnel assisted the geologists in this work, particularly regarding the type of drilling rig that would be employed to drill the well, its arrangement on the location, noise that would ensue, mud pits, water supply, and waste fluid disposal.

Several meetings and informal discussions were arranged to plan for geophysical research tests, and electric logs that would be made on the proposed well. This included conferences with General Crude Oil and The University of Texas people, including D. G. Bebout, R. G. Loucks, A. R. Gregory, and M. M. Backus, and DOE personnel. It was agreed that if well circumstances did not prohibit, General Crude Oil would run electric logs and make surveys on the proposed well to measure seismic wave characteristics, using special equipment to be recommended by The University of Texas. This included open hole logs using a Schlumberger Long Spaced Sonic log (LSS), with a special magnetic tape record that would permit digital readout. Cased hole surveys would be run using a Birdwell locked geophone in the well to record horizontal and vertical wave forms, that would be developed from a "Vibroseis" energy source on the surface. It was agreed that this survey would be run at 15,000 feet and at total depth after casing was set in the well. A similar survey would be run in open hole in one of the shallow wells drilled for saltwater injection.

Coring points were selected on the Texas Co. and Ft. Bend No. 1 Houston Farms well, the closest to the Pleasant Bayou test well. Based on known expansion of section and detailed correlation, these points were projected to an interpreted depth in the test well.

Plans were made to have Core Laboratories pick up the core at the time it was taken, wrap it in plastic to retain moisture, and deliver it to their facilities in Houston. Porosity/permeability analyses were to be taken every one foot in the sandstones and a gamma-ray scan taken in order to facilitate correlation to exact subsurface depths. The core was to be rewrapped and shipped to the Bureau of Economic Geology Well Sample Library at The University of Texas at Austin.

The core was to be unwrapped and a one- to two-inch slab taken lengthwise to become the permanent geological set. The larger portion was to be delivered to the Rock Mechanics Laboratory of the University for further testing. The Rock Mechanics Lab was to provide a set of core plugs to Institute of Gas Technology, Chicago, for rock properties studies. A. R. Gregory obtained several sandstone samples for future rock velocity studies. It was arranged with the mud-logging unit to have one large shale sample canned at the well site for future delivery to the USGS for isotope analyses of the gas. The core plugs, taken by Core Lab for analyses, were to be delivered to the Bureau of Economic Geology (R. G. Loucks) to be thin sectioned and examined for pore type and diagenesis.

Supplemental funding (\$24,400) was obtained from Gas Research Institute, Chicago, to collect and analyze samples for organic geochemistry. The geochemical studies were subcontracted to Geochem and Geostrat companies of Houston.

One-month funding of the microseismic monitoring was provided through the coordination contract in order to maintain continuity between contracts for this service. In addition, a mechanical weather station was purchased (\$3,123) for environmental monitoring when the Federal

weather records were found to be inadequate. This battery-operated unit measures rainfall, wind velocity and direction, and air temperature.

Subtask 2

Technical assistance was given by Center for Energy Studies personnel to the field contractor, for on-site evaluation of data and logs obtained during drilling operations. This included cores — both conventional and sidewall samples — electric logs and surveys, mud log data, and cuttings analysis.

Nine conventional cores were obtained while drilling at the following depths: 4,300; 6,700; 10,215; 11,732; 12,580; 14,053; 14,747; 15,147; and 15,543. Depths at which these cores were cut were chosen by D. G. Bebout and R. G. Loucks of The University of Texas personnel, and General Crude Oil geologists. The cores were collected on location by Core Laboratories under the direction of W. E. Boyd, and physical analyses were made in Houston. The attached Core Analysis Report, Appendix E, shows the results of this work. After these laboratory tests, the cores were wrapped in plastic and sent to the Balcones Cuttings and Sample Library in Austin for storage and reference. Samples were delivered to the Earth Sciences Center at Balcones, attention Dr. K. E. Gray for rock mechanics studies. Sidewall core samples, taken by a percussion device lowered into the well on a wireline, were shot at various depths when electric logs were run at 8,478 feet. Sixty-six shots were attempted; thirty-four samples were recovered. D. G. Bebout, M. H. Dorfman, and H. F. Dunlap of The University of Texas made the depth calls at which these shots were made. These samples were sent to Core Laboratories in Houston for analysis; results are given on the accompanying Core Analysis Report mentioned above.

Electric logs, porosity, radioactivity, and temperature surveys were run on the well at 8,478 and 14,758. D. G. Bebout, M. H. Dorfman, H. F. Dunlap, and W. E. Boyd, all of The University of Texas, were on site when most of these logs were taken to evaluate results and make recommendations for additional surveys. See the attached logs for results, Appendix F.

Bureau geologists were on site during the logging run at 8700 feet in order to substantiate correlations from drilling time and to pick sidewall-core points. During subsequent logging runs, Bureau personnel were in close contact with the General Crude geologist, Jim Kelly, who was at the well, but it was not believed necessary to be at the site.

Exploration Logging Company was employed by the field contractor for mud logging and to maintain a Pore Pressure Evaluation Log while drilling. Copies of the daily progress reports, as prepared on the job, were sent to D. G. Bebout and W. E. Boyd in Austin. Copies of the 1" scale Correlation Log and Pore Pressure Evaluation Log are attached, Appendices F-7 and F-8. These were employed for correlation purposes to predict depths for coring and other purposes. The mud log information as to drilling rate, lithology, oil, and gas shows were reported routinely to the operational supervisors of the drilling operation. The mud log record was found to have good correlating with the lithology recorded on electric logs subsequently run at 8,478 and 14,758. Calculated formation pore pressure gradients were found to be as much as three pounds per gallon (ppg) higher than actual.

Cuttings for methane analysis were obtained every sixty feet as drilling proceeded and delivered to Geo Chem Laboratories in Houston for methane analysis. This information is for a geo-chemistry research

project being managed by the Bureau of Economic Geology under D. G. Bebout that is separately funded by the Department of Energy.

Subtask 3

Technical assistance to determine the optimum completion and testing strategy based on data obtained while drilling was not accomplished because the well was not completed during the period under review. The well kicked 14.3 mud while drilling 14,484 feet and 80 psi was measured at the surface. This would indicate 10,850 psi formation pressure at that depth. When the well kicked from 15,675 feet, shut-in pressure was 200 psi on top of 16.3 ppg fluid at 10,051. Assuming saltwater to total depth, the indicated formation pressure can be calculated to be in excess of 11,200 psi. Maximum bottomhole pressure can be assumed to be 12,000 psi for design purposes.

Planning for completion and testing strategy was performed by W. E. Boyd, per the attachment "Drilling and Completion Plans for A Geopressured Well," previously referenced, Appendix D. This work was reviewed by the field contractor and others at the Third Geopressured Conference held in Lafayette.

Subtask 4

The Center for Energy Studies provided technically qualified personnel for on-site evaluation of well data when requested by DOE-DGE.

Most of this work was performed by W. E. Boyd by periodic visits to the test well while drilling operations were in progress. M. H. Dorfman, D. G. Bebout, and H. F. Dunlap made evaluations of the electric logs and surveys that were obtained when the well reached 8,478 feet depth.

BEG geologists were in daily contact with GCO geologist, Jim Kelly, concerning detailed correlation of the test-well drilling time records with existing wells nearby. Coring points were picked in this way.

Subtask 5

The Center for Energy Studies provided coordination for the handling of cores and cuttings and routine analysis/testing by the Bureau of Economic Geology and other DOE contractors.

Cores and cuttings from the test well were processed and analyzed by Core Laboratories and Exploration Logging personnel, as described under Subtask 1. As previously mentioned, these results were forwarded to W. E. Boyd for the Center for Energy Studies and others involved with research contracts funded by DOE at The University of Texas. This included M. H. Dorfman, D. G. Bebout, R. G. Loucks, A. R. Gregory, and K. E. Gray.

Task 2

The Center for Energy Studies provided for the technical evaluation and dissemination of results obtained from the test well.

Subtask 1

Daily reports were received on the drilling progress of the well as work proceeded. See the attached Drilling Report "GCO-DOE Pleasant Bayou No. 1," Appendix C. This report was distributed to M. H. Dorfman and D. G. Bebout at The University of Texas and other interested parties. At certain times, telephone reports were obtained in anticipation of depths for coring, logging and other operations on the well. Core and cuttings samples, previously mentioned, were collected and distributed

as the information became available. These reports were sent to M. H. Dorfman, D. G. Bebout, K. E. Gray, and A. R. Gregory. Field prints of the electric logs were picked up at the well site when the surveys were run and similar distribution made. Final prints of the composite log and other surveys were obtained at the end of the job and sent to the people named above. Copies of the core analyses and electric logs were sent to another DOE contractor, Gas Research Institute (GRI) in Chicago, Illinois, to the attention of Phillip Randolph.

Bureau of Economic Geology personnel were called upon to review the status of the geopressured geothermal test well at a large variety of meetings. Among those are:

Geological and Engineering technical meetings. Annual meetings, noon luncheon meetings of societies, short courses, symposia, etc.

Department of Energy Geopressured Geothermal Conferences.

CES/BEG reviews, briefings, news releases.

C.K. Geoenergy Industrial Workshops.

Wells of Opportunity Reviews.

Subtask 2

The Center for Energy Studies assisted interested research units in utilizing available data and samples as quickly and effectively as possible.

M. H. Dorfman, D. G. Bebout, K. E. Gray, A. R. Gregory and others of the Center for Energy Studies were given daily reports of progress on the test well as drilling proceeded. This included operational information concerning the well location, preparations and plans for drilling the well, and technical details as the work developed. As soon as cores and logs became available, copies of the laboratory analyses were passed

to all interested parties. Copies of these data are attached, Appendix E.

Analyses of the organic content and maturation degree will be available to those interested as soon as the #2 well is completed.

Subtask 3

The Center for Energy Studies collected well data from the various organizations that performed tests and analyses and provided a single repository for these data.

All core, core analyses, and logs from the Pleasant Bayou well are stored at the Bureau of Economic Geology and at the Center for Energy Studies, The University of Texas. When released by DOE, these data will be available to all interested parties.

Subtask 4

Analyzed all collected test well data and reported results to the DOE designated field operator for inclusion in the yearly or final report of the drilling and testing contract.

Preliminary logging has been completed of the core from the #1 Pleasant Bayou well. Thin sections have been prepared from the core analysis plugs and other intervals. These thin sections are now being examined for the diagenesis project at the Bureau. Other selected samples have been observed in greater detail on the SEM (scanning electron microscope) for types of clay minerals, primary and secondary, in the pores.

Subtask 5

Provided technical assistance in formulating and suggesting future tests on the well locations for additional test wells, and suitable production strategies for chosen Geopressure Geothermal reservoir.

Four additional geopressured geothermal test-well sites have been identified and have been described in a preliminary "Prospectus." Appendix G is a summary of the report which has had very limited distribution.

4. TECHNICAL ASSISTANCE, COORDINATION, AND PLANNING OF SURFACE COMPONENT TEST FACILITIES AND PILOT PLANT

Task 1

Planning of test facilities for surface components has encompassed three major technical programs as outlined in the subtasks below. The overall director of the surface technology program was Professor J. Parker Lamb of the Mechanical Engineering Department. Associate Investigators included Professors R. L. Panton and Z. Eliezer of the Mechanical Engineering Department. Research assistants are identified below.

Subtask 1

Limited well test data has prevented significant accomplishment. However, based on preliminary data from the drilling program and from information developed by Professor Lamb during a visit with Mr. McFarland of DOE-DGE, it appears that a test facility is highly desirable. The size and economic feasibility of such a facility has yet to be established.

Subtask 2

Professor Z. Eliezer has initiated an extensive metallurgy and corrosion study during the period. Assisted by Mr. H. E. Mecredy (M.S. degree candidate), the following work has been accomplished:

- (1) An intensive literature survey of the potential corrosion problems in geothermal environments has been performed.
- (2) A rack for atmospheric corrosion tests has been constructed and is ready for installation at the well site.
- (3) Most of the materials needed for the atmospheric corrosion tests have arrived and are in the process of machining in accord with ASTM standards.

- (4) In the absence of brine samples from the well, some synthetic brine has been prepared, and the corrosion behavior of low carbon steel as a function of brine composition is under investigation. The work is intended to characterize the nature and kinetics of the corrosion product. Optical and electron microscopy, as well as Auger electron spectroscopy, will be used in the investigation.
- (5) A state-of-the-art corrosion apparatus has been ordered from Princeton Applied Research Company and is expected to arrive in May 1979. This apparatus will be used both in UT laboratories as well as at the well site (within a "test trailer"). This apparatus will enable us to measure corrosion currents and corrosion rates as well as to develop polarization curves.
- (6) Monthly progress reports were prepared and forwarded to Dr. Myron Dorfman.

Subtask 3

Professor Panton, assisted by Mr. H. Y. Kwak (Ph.D. candidate), has begun preliminary investigation of a rotary gas separator which would permit efficient separation without significant loss of pressure by the geopressured brine. Theoretical studies are in progress to determine the feasibility of constructing a laboratory model. Should this feasibility study show promise, a separate proposal for further development funds would be submitted to DOE.

During the next contract period, Professors Lamb and Eliezer will be visiting various DOE and industry test sites in Idaho and California to discuss test facilities design.

Subtask 4

This work has been delayed until the test well is completed and the test facility complete.

Subtask 5

Professor Lamb, assisted by Mr. D. L. Rhode (M.S. candidate), has completed the development of a mathematical model for wellbore flow including effects of heat loss to geological formation, scale growth in the wellbore, and reservoir depletion. The model allows one to estimate the energy content of two-phase wellhead fluid (brine plus methane) at entry into a surface utilization plant. This work has been reported in the following publications:

- (1) Rhode, D. L. "A Computer Simulation Model for Two-Phase Wellbore Flow of Geopressured Geothermal Fluid," M.S. Thesis, May 1978.
- (2) Rhode, D. L. and J. P. Lamb, "A Computer Simulation Model for Two-Phase Wellbore Flow of Geopressured Geothermal Fluid with Emphasis on Texas-Louisiana Gulf Coastal Fairways," Report ME EFS 78001, February 1978, Department of Mechanical Engineering, The University of Texas at Austin.
- (3) Lamb, J. P. and D. L. Rhode, "Wellbore Flow Simulations for Texas-Louisiana Geopressured Reservoirs," Paper 7543, Society of Petroleum Engineers, October 1978.

General Comments

The surface technology program also receives financial support from the United Gas Pipeline Company which is sponsoring an experimental study by Professor Panton of the detailed mechanisms of gas nucleation during the separation process. This study is in its third year and is nearing a conclusion.

A consortium of three electric utilities in Texas is also providing partial support of the study of designs for geopressured conversion plants. This study is directed by Professor Lamb and will concentrate

on identifying specific plant components (such as hydraulic topping units, flash or binary units) for any desired output energy profile (electric power, methane feedstock, cogeneration, etc.). Representatives of the utilities meet periodically with UT personnel to review progress and plan future tasks.

5. LEGAL RESEARCH IN GEOPRESSURE GEOTHERMAL RESEARCH DEVELOPMENT

Legal research during the contract period, 1 October 1977 through 31 October 1978, carried out a single directed task: "Provide legal research support to appropriate management and staff sections."

Four subtasks were prescribed, as follows:

Subtask 1. Maintain surveillance of new developments in the legal and regulatory areas which might affect the orderly development of geopressured geothermal resources; analyze the significance of these developments; and advise other elements of the geopressured program of the possible impact of these developments.

Subtask 2. In coordination with ERDA staff personnel, identify and specify necessary legal research projects.

Subtask 3. Within the limits of this contract, conduct required legal research. Where the scope and legal research is beyond the scope of the contract, aid in the identification of appropriate agencies to conduct the research, assist in the preparation of proposal requests, evaluation of proposals, and contract monitoring, where appropriate.

Subtask 4. Provide legal and regulatory information and data to other elements of the geopressured geothermal program as requested.

Progress on these subtasks is reported below:

Subtask 1

General

Surveillance of new developments in the legal and regulatory areas was executed by a continuing review of legal literature in the natural resources and environmental law fields. Additionally, State Bar of

Texas and American Bar Association conferences on environmental law developments, and on the national energy policy and environmental barriers to energy development were attended. An extensive liaison with pertinent state agencies was continued.

Specific results of such surveillance during this contract year are summarized below:

TRANSCO Patents

In early October, 1978, M. H. Dorfman heard that several patents, possibly related to geopressed geothermal development, had been granted to a subsidiary of TRANSCO. A. W. Oberbeck researched the matter, corresponded with Ernest C. Geer, Chief Engineer of TRANSCO Energy Company, who was a co-inventor on these patents, and obtained copies of them for review.

At Mr. Geer's request, a meeting was held in Lafayette, Louisiana, during the geothermal conference there in November, 1977. Mr. Geer was accompanied by two attorneys for TRANSCO, and Mr. Oberbeck secured attendance of Don Elmer and Ron Stearns of DOE, Washington and Las Vegas, respectively. Mr. Geer was interested in any quid pro quo he might obtain in exchange for a patent waiver for our project.

The final project work product was a memorandum with seven enclosures to Keith Westhusing of DOE summarizing the matter. We understand that Mr. Geer has continued to pursue his patent interests with DOE. Final completion of this subtask element is a federal government legal responsibility.

Reorganization of Texas Water Agencies

During the 1977 session of the Texas Legislature, a bill was passed to combine three previously independent state water agencies into a new, unified Department of Water Resources. A. W. Oberbeck maintained liaison with staff members of the new department during its organization to assess changes in structure and policies which might affect our project in the future. Written progress reports and oral summaries were given to concerned project staff members.

Waste Fluid Disposal

In addition to monitoring the reorganization of the state water agencies, A. W. Oberbeck maintained liaison with the new staff at the Department of Water Resources and with the Railroad Commission staff to assess progress toward state assumption of federal water pollution control duties now performed by EPA.

In Texas, the regulatory controls over waste fluid disposal requirements of potential geopressured geothermal development continue subject to most of the uncertainties discussed in the project legal research report of 1 July 1977.

With regard to surface disposal of fluid wastes, both the Texas Department of Water Resources and the Railroad Commission are continuing discussions with EPA relative to delegation of NPDES permit authority to the state. In 1977, the Texas legislature authorized changes in the Water Code to satisfy federal requirements. However, these changes cannot become effective unless EPA delegates permit authority to Texas for all or a part of the NPDES program. EPA insists that any delegation of permit authority to the state will be for the entire program, including both Department of Water Resources and Railroad Commission

responsibilities. Thus, Texas continues to have dual systems of control, one federal and the other state, for surface fluid disposal. A Texas negotiator estimated that if everything goes well in the present discussions, and if no further problems evolve, it will be sometime in calendar 1979 before EPA will be ready to hold the required public hearings on their intention to delegate surface disposal permit authority to the state.

With regard to subsurface injection of fluid wastes, Texas permit controls continue in effect. However, no federal system of control by EPA under authority of the Safe Drinking Water Act of 1974 has been implemented yet. Proposed federal rules were published in the Federal Register in August, 1976. Because of extensive adverse reactions, a major revision of these rules was circulated as a draft of April, 1978, without formal publication. Another draft was again circulated informally in August, 1978. It was rumored that EPA will make minor changes to the latest draft and publish it formally in the Register soon. The changes which have been made to date are directed toward allowing greater flexibility for state regulatory agencies, and apparently to avoid substantial interference with oil and gas production. However, it still appears that an expensive, procedurally complicated, and time consuming, federal regulatory system will be established before much longer. Dual level controls can be expected for some time thereafter.

Reports on this research were made by memorandum in a monthly project progress report, orally to a legal working group conference in Houston sponsored by DOE, and in a presentation to the Third Geothermal Conference in Lafayette, Louisiana. The text of this presentation was published in the conference proceedings.

The task will continue until EPA completes new subsurface disposal regulations, and enforcement authority for these and NPDES permits are transferred to state agencies in Texas.

Multicompletion Problems

A decision by the Supreme Court of Texas (Railroad Commisison v. Graford Oil Corporation, 557 S.W. 2d 946) at the end of 1977 could complicate geopressured geothermal development planning. This was reported by Fred Young of the Railroad Commission staff and analyzed by A. W. Oberbeck.

In 1976, the Railroad Commission approved the consolidation of nine gas fields in Palo Pinto and Jack Counties into one field for proration purposes. In doing this, the Commission found that the geological formation producing gas in this field consisted of interspersed sections of conglomerate and shale which formed correlatable but not continuous reservoirs. While recognizing the discontinuity of individual reservoir lenses, nevertheless, because of their apparent correlation and apparent merging, the Commission decided that the entire section could be reasonably developed as a single reservoir.

When this concept was opposed by Graford Oil in the cited case, The Texas Supreme Court found that all of the producing areas involved were both vertically and horizontally separated with no natural communication between them. Strictly construing the statutory authority of the Commission to prorate and regulate production of gas from a "common reservoir," and the statutory definition for that, the Court held that there was not a single gas-producing formation, continuous throughout the consolidated area, and the Commission was without authority to regulate it in that way.

Although the operators of record on the affected land had an opportunity to present evidence, the Court also held that owners of unleased lands in the field area had been denied due process when they were not permitted to participate in the Commission's hearings.

While geologically entirely different, of course, the geopressured geothermal reservoirs, which appear to consist of numerous bodies of sand contained in a shale bed, seem to have a broad physical parallel in the conglomerate reservoirs of the Graford fields. Our present geological estimates appear to suggest a series of overlapping, interspersed, but not necessarily continuous reservoirs. Unless the authority of the Railroad Commission, now in the Natural Resources Code, is modified, the Commission may not be able to regulate such reservoirs as "common reservoirs." Consequently, Statewide Oil and Gas Rule 6 of the Railroad Commission, which applies to geothermal resources, and deals with multi-completions, may be important for a geothermal well. Typical well logs from the geothermal fairway areas show many fairly thin layers of geopressured sands, separated by layers of shale. It may be necessary to produce concurrently from a number of these multiple sand layers for adequate fluid production from an expensive, deep well. The operator of a geothermal resource well may be granted authority to multicomplete the well in these separate layers, or "reservoirs," provided he files a multicompletion application with the Railroad Commission. However, Statewide Rule 10 will also come into play, since it forbids production of geothermal resources from different strata through the same string of casing. Strata would have to be defined in a sufficiently broad way to permit the efficient production of geopressured waters without violating the ban against commingling under Rule 10.

If we have to produce something like 300 feet of sand over a well completion zone on the order of 1200 feet, Rule 10 would deny production of adequate volumes of fluid from a single deep well. In order to avoid multiple wells to get the necessary 30,000 to 40,000 barrels of fluid in daily production, it appears that the fluids from all completion horizons must be commingled. Even if the Railroad Commission is sympathetic to this need, the Graford case seems to complicate such an option.

The work product was a memorandum which was distributed as part of a project monthly progress report. Additionally, the matter was presented at a legal working group conference in Houston sponsored by DOE.

Subsequent to this contract year, discussions were held with Railroad Commission legal staff members and agreements reached as to desirable legislative and regulatory changes which they will pursue. The nature of this agreement is discussed in the memorandum, "Statutory and Regulatory Changes," dated November 16, 1978 (Appendix H) and the section "Protection of Correlative Rights" under Subtask 3.

Air Pollution Controls

EPA concepts of non-degradation of air quality, and progress toward increasingly severe ambient standards and emission controls suggest the difficulties any future industrial development must face.

On 3 March 1978, EPA published attainment status designations relative to national ambient air quality standards (NAAQS) for all air quality control regions (AQCR), nationwide, on a pollutant-by-pollutant basis. Brazoria County is part of AQCR No. 216, Metropolitan Houston-Galveston. This AQCR is better than the national standards for total suspended particulates (TSP) except for limited areas in Galveston and Harris Counties. These limited areas have been designated as nonattainment

areas for TSP. All three counties (Brazoria, Galveston, and Harris) were found not to meet the primary standards for photochemical oxidants (O_x), and are nonattainment areas for that pollutant.

As a result, state implementation plans (SIP) must be revised to provide for attainment of the NAAQS in these areas as soon as practicable, but not later than 31 December 1982, for TSP. This may be delayed until 31 December 1987, for the photochemical oxidants, if certain findings are made by EPA. Prior to 1 July 1979, construction and operation of major new or modified stationary sources in the nonattainment areas will require permits under EPA's emission offsets policy. After that date, the SIP must prohibit major new source construction or modification in these nonattainment areas where emissions from the source would contribute to increases in the pollutants which are exceeding the national standards, unless the SIP meets the statutory plan requirements for nonattainment areas at the time of the permit application.

Even though the TSP level in Brazoria County is better than the national standards, any major new construction there must be reviewed as to its impact on the nearby areas in Galveston and Harris Counties which do not meet the primary standards.

AQCR No. 216 is better than the national standards for TSP (except in the limited areas previously noted), for sulfur dioxide (SO_2), for carbon monoxide (CO), and for nitrogen dioxide (NO_2). Where at least one NAAQS has been attained in an area, prevention of significant deterioration (PSD) rules will be applied. These rules also require permits for major construction to limit pollutant increments. At present, only particulate matter and sulfur dioxide are controlled in this way, but Congress has directed EPA to extend such regulation to include nitrogen

oxides, hydrocarbons, carbon monoxide, and photochemical oxidants. Given the facts that the EPS regulations in these areas are unannounced, that state implementation plans are not drawn, and that the nature and amounts of volatile substances that will be produced by geopressured wells is unknown, it is difficult to predict the impact of future roles on geopressured-geothermal energy production. However, it appears unlikely that air quality rules will naturally affect test well operation.

Subtask 2

Due to delays in the start of the test well in Brazoria County, and its subsequent plugging back, there was a corresponding lag in legal research because of the absence of test well data. However, it was felt that actions by the state legislature in its 1979 session might have serious impact on future geopressured-geothermal development. Hence, it was recommended that the program's legal capabilities be enhanced to permit continuing close liaison with the legislature and the governor's office. It was also recommended that a careful study be made of the possible liabilities accruing to each of the test well parties and of the relevant insurance coverage required and in force.

Subtask 3

Protection of Correlative Rights

Preliminary legal research was undertaken during late 1977 and early 1978 relative to protecting correlative rights during geopressured geothermal resource development. Two aspects of the problem appear most significant. First, we are concerned with an adequate resource production rate, and with protection of reservoir life in order to justify

extensive resource field development, and construction of necessary energy conversion facilities on the surface. Second, we must assure a fair opportunity for participation in resource development, and avoidance of uncompensated resource drainage, for all resource owners having interests in common reservoirs.

Texas now has a compulsory oil and gas pooling law, but forced unitization has been consistently opposed within the legislature. Voluntary unitization, which is permitted, has definite limits, even for these minerals. Geothermal resources are not included in the present Texas statutes for either compulsory pooling or voluntary unitization. Various geothermal legal researchers have suggested forced unitization as a necessity for effective geothermal resource conservation and efficient development. However, such analyses and conclusions have not considered the geopressured geothermal resources specifically, or the special problems arising in Texas as a result of a long history of major oil and gas development. Extended discussions by A. W. Oberbeck with Railroad Commission legal staff members led to a conclusion that our inadequate knowledge of reservoir dimensions and performance under long term production, together with insufficient data on resource constituents and salinity profiles, preclude a useful analysis of correlative rights problems until we get substantial test well production data. Additionally, performance data on small-scale wellhead generators of various kinds now being developed and tested under DOE direction are critical for assessing the possibility of single well development as a viable alternative to large reservoir dedications. Our preliminary research has developed the necessary background for later analysis and has been of benefit in assessing collateral work being done by others.

Since the testing of the Brazoria fairway was delayed so long, it was not possible to analyze the correlative rights problems in time for them to be considered by the 1979 Texas legislative session. Such an assessment should be available in time for consideration by the next biennial regular session of the Texas legislature in 1981.

Test Well Legal Aspects

A detailed functional analysis of the four principal organizations involved in establishing a geopressured-geothermal test well program was prepared by A. W. Oberbeck in consultation with W. E. Boyd. The organizations considered were:

- (1) The federal administrative agency, DOE, under whose direction and funding the program would be established and executed.
- (2) The in-state, technical representative of DOE, the geothermal project group at the CES, The University of Texas at Austin, responsible for designing, and evaluating the results of the test well program.
- (3) The land owner of the proposed test site, General Crude Oil Company.
- (4) An operating company, a DOE prime contractor for field operations, responsible for executing the test well program. This could also be General Crude, and this did occur.

The following functions were recommended for the organizations:

Technical Representative Agency — The University of Texas at Austin.

- (1) Site Selection — Recommend an optimum site for the test well program for approval by DOE.

- (2) Test Program Design — Develop the general test well design. Specify the overall testing and sampling program required for resource assessment. Establish the overall parameters within which the specific program elements will be defined by the operating company. The testing program will include both static and dynamic testing for:
 - (a) determination of reservoir characteristics, geology, lithology, rock mechanics, fluid characteristics, productivity, etc.
 - (b) assessment of surface utilization components which require test, possibly including fluid-gas separation devices, energy conversion components, and gas recovery equipment.
- (3) Negotiation Assistance — Assist DOE by discussions with General Crude for site acquisitions.
- (4) Operating Company Requirements — Assist by determining the character of the field operations task, and criteria for selection of the operating company. Provide professional advice in selection of this prime field contractor of the government for the test well program execution.
- (5) Performance Inspection — Act as the field representative of DOE for inspecting contract performance of the operating company. Coordinate as necessary in the adjustment of the test program specifications to accomodate field conditions encountered.
- (6) Test Evaluation — Evaluate operations reports, logging records, and other test data. Arrange for sample analysis as required. Provide evaluation consultants as needed. Make an overall

evaluation of the test program, and report results. Recommend disposition of the test well, or additional testing programs, as appropriate.

Operating Company — An oil and gas development company. This company is the executive agency to conduct all field operations of the test well program, and should have overall responsibility for carrying out the field program. Functions include:

- (1) Select Subcontractors — The detailed design of the test well, and elements of the test program must be developed by a team of specialist service organizations who execute their portions of the program under subcontract to the operating company. Each company has special expertise in its field which must be exploited.
- (2) Plan and Develop the Drilling Program
 - (a) bit program
 - (b) mud program
 - (c) casing program
 - (d) logging program
- (3) Plan and Develop the Completion Program
- (4) Plan and Develop the Effluent Disposal Program — This program should consider both surface and sub-surface effluent disposal alternatives, and assess the comparative costs, permitting feasibility, and environmental effects of each.
- (5) Secure Required Permits — The legal capabilities of the operating company organization should be used, as appropriate. Federal, state, and local permits may be required for drilling, construction, effluent disposal, etc.

- (6) Prepare the Site — Construction of access roads, drilling rig accomodation, surface test facilities, effluent disposal wells, or facilities for surface disposal, etc.
- (7) Drill the Well
- (8) Operate the Well
 - (a) conduct scheduled static and dynamic tests
 - (b) gather required samples and data
 - (c) conduct the surface utilization tests
 - (d) dispose of the effluent and other drilling refuse
 - (e) shut-in the well temporarily as required
- (9) Report Test Data — Turn over reports on operations, logging records, samples, etc. to UT-Austin which will carry out necessary analysis, evaluation, and overall test reporting.
- (10) Restore the Well Site — In accordance with requirements to be established, arrange to salvage removable property, plug-in the well, and restore the well site. Alternatively, turn over the well and associated equipment to others, as directed.
- (11) Develop Insurance and Bonding Program — At an early time, develop the necessary insurance and bonding program to meet federal and state requirements, and hold the State of Texas, The University of Texas at Austin, and contract agencies harmless for execution of the test well program.

Land Owner — General Crude Oil Company. The only requirement for the land owner, who in the case of the prospective Brazoria County test well site owns both mineral and surface estates, is to lease the site to the federal government for the test well program. It is possible that the land owner will be willing to act as the operating company, and this has distinct advantages.

Federal Administrative Agency — DOE.

- (1) Program Approval — Approve the concept of a test well program.
- (2) Technical Representative Contract — Contract with UT-Austin as the in-state, technical representative of DOE to carry out the functions listed above.
- (3) Site and Program Approval — Approve the site selection and general test program design as developed.
- (4) Lease the Test Site — Negotiate, with UT-Austin assistance, to secure a term lease for the test well site area from the landowner. Secure the lease for the federal government.
- (5) Operating Company Contract — Select an oil and gas development company to perform the operating company functions listed above, and negotiate a contract for execution of these functions. Conclude the contract for the federal government.
- (6) Funding — Fund the test well program.
- (7) Long-Lead Procurement — Approve procurement of long-lead time equipment needed.
- (8) Administration — Administer the program for the federal government.
- (9) Well Disposition — Determine the disposition of the test well after program completion. Arrange for further testing of the well, as appropriate.

A memorandum containing the analysis shown above, and other material having to do with descriptive material on oil and gas lease forms and mineral interests were distributed to project staff members involved in the contract negotiations with General Crude Oil Company. Copies were also sent to DOE and General Crude.

Subtask 4

Informational Presentations

Presentations were made upon request at three legal working group conferences in Houston as part of the DOE/Industry orientation program. A paper was requested on regulatory controls over water pollution in connection with the Third Geopressured Conference and presented there at Lafayette, Louisiana, by A. W. Oberbeck. Mr. Oberbeck also participated in numerous project briefings for government and industry visitors. This work is summarized chronologically under the listing of Attended Meetings, Lectures, and Public Addresses - Appendix B.

Monthly Progress Reports

Legal research activity reports were presented orally at monthly project staff meetings, and written summaries included in the monthly project progress reports.

Recommendations for Texas Legislation

Former Chairman Mack Wallace of the Texas Railroad Commission, in connection with his appointment as former Governor Briscoe's representative for policy and planning of geothermal development in Texas, designated Fred Young of the Railroad Commission staff to chair an ad hoc legal committee to examine problems related to the regulation of geothermal activities by the Railroad Commission. The committee was asked to recommend any legislation which could alleviate potential legal problems.

A committee consisting of Fred Young and Mel Waxler of the Railroad Commission staff, and A. W. Oberbeck of the CES geothermal project staff met on 19 January 1978, in the Railroad Commission offices. Primary consideration was given to the two completed CES legal studies on

ownership and royalty issues, and on regulatory controls over water pollution. Only those areas which promised early resolution were of interest in this first meeting of the committee.

The committee recommended to Chairman Wallace a legislative change in the Water Code to clarify current Railroad Commission duties prescribed in Sec. 21.261 of the code. The change was to add geothermal resources to the existing Commission responsibilities for oil and gas. This appears to have been the legislative intent in the Geothermal Resources Act, but the change would resolve a possible ambiguity as to Railroad Commission versus Department of Water Resources responsibility.

The committee also recommended two changes in the Texas Geothermal Resources Act (now part of the new Natural Resources Code). One change recommended in Sec. 141.002 of the code would add a sub-paragraph stating that geopressured geothermal resources in Texas shall be treated and produced as mineral resources. Another recommended change would clarify a possible ambiguity in the definitions of Sec. 141.003 to provide that methane is a by-product of geothermal energy and associated resource development whether or not it is separated from the geopressured waters before their use in energy generation.

6. OPERATION OF GEOPRESSURE GEOTHERMAL INFORMATION SERVICE (GGIS)

Task 1

GGIS has identified several hundred individuals and organizations who are participating in the development of the geopressure geothermal resource.

Subtask 1

GGIS has established and maintains a mailing list of individuals, organizations, and government agencies who have expressed active interest in development of the geopressure geothermal resource. The list is categorized so that sub-lists may be instantly produced for special mailings. Mailing labels are typed automatically from the computer listing.

Subtask 2

GGIS has been operational and responsive to users at UT Austin. User services have included the production of a well-log header data base, development of header analysis software, and preparation of bibliographic listings.

The publication of the newsletter, listed in this subtask, and other external publicity were deferred pending authorization by the Department of Energy via approval of a new contract for GGIS.

The "newsletter" will be a low-budget publication of current developments in GGIS as significant milestones are reached. It will be sent to a DOE approved mailing list. This will be the publicity specified in Task 1 of the current proposal.

Task 2

GGIS has continued development of its library of digitized well-logs and associated header information. Software has been developed for selective extraction, analysis and plotting of well-log data. Research efforts have been developed to expand the log analysis and graphics software to include investigation of permeability, porosity, compaction, etc.

Subtask 1

GGIS has digitized approximately 1,000,000 curve-feet from some 100 well-log traces at the request of UT Austin geopressure researchers for use in site specific reservoir evaluations. A Header data base and index of more than 5000 logs has been prepared at the request of researchers in the Bureau of Economic Geology.

Subtask 2

A total of 813 well-log curves (8,566,850 curve-ft) have been digitized for addition to the library. The accent during this contract period has been on the area in and near the Brazoria Fairway. The tables on the following pages list the types of curves and curve-feet digitized by county.

LOGS DIGITIZED BY GGIS (listed by county and curve type):

WOOD COUNTY

CURVE TYPE	CURVE COUNT	CURVE FEET
ACOUSTIC COMPENSATED	1	11,432.0
CALIPER	1	11,432.0
SELF POTENTIAL	1	11,432.0
TOTALS FOR WOOD COUNTY	3	34,296.0

BRAZORIA COUNTY

CURVE TYPE	CURVE COUNT	CURVE FEET
ACOUSTIC COMPENSATED	20	217,112.0
ACOUSTIC NON-COMPENSATED	13	147,538.0
AMPLIFIED FOCUSED RESISTIVITY	10	123,920.0
AMPLIFIED SHORT NORMAL	69	763,796.0
CALIPER	34	315,730.0
DENSITY (API UNITS)	4	21,588.0
DENSITY (COMPANY UNITS)	1	8,438.0
FOCUSED RESISTIVITY	12	143,226.0
GAMMA RAY (API UNITS)	8	81,180.0
GAMMA RAY (COMPANY UNITS)	1	2,830.0
INDUCTION (CONDUCTIVITY)	58	651,678.0
INDUCTION (RESISTIVITY)	58	661,924.0
INVERSE (1 INCH)	4	18,528.0
LATERAL	26	277,410.0
LONG NORMAL	25	262,130.0
MONITOR	4	21,588.0
NEUTRON (API UNITS)	1	1,200.0
NEUTRON (COMPANY UNITS)	1	2,830.0
SELF POTENTIAL	111	1,175,088.0
SHORT NORMAL	71	778,806.0
TOTALS FOR BRAZORIA COUNTY	531	5,676,540.0

FORT BEND COUNTY

CURVE TYPE	CURVE COUNT	CURVE FEET
AMPLIFIED SHORT NORMAL	6	44,146.0
INDUCTION (CONDUCTIVITY)	4	28,342.0
INDUCTION (RESISTIVITY)	4	28,342.0
LATERAL	2	15,804.0
LONG NORMAL	2	15,804.0
SELF POTENTIAL	7	49,194.0
SHORT NORMAL	7	49,194.0
TOTALS FOR FORT BEND COUNTY	32	230,826.0

GALVESTON COUNTY

CURVE TYPE	CURVE COUNT	CURVE FEET
ACOUSTIC COMPENSATED	5	52,050.0
ACOUSTIC NON-COMPENSATED	4	15,768.0
AMPLIFIED FOCUSED RESISTIVITY	4	55,354.0
AMPLIFIED SHORT NORMAL	33	374,006.0
CALIPER	13	84,450.0
DENSITY (API UNITS)	1	3,178.0
FOCUSED RESISTIVITY	5	65,316.0
GAMMA RAY (API UNITS)	4	49,240.0
INDUCTION (CONDUCTIVITY)	27	324,322.0
INDUCTION (RESISTIVITY)	26	312,420.0
INVERSE (1 INCH)	4	16,632.0
LATERAL	13	137,460.0
LONG NORMAL	13	137,460.0
MONITOR	1	3,178.0
SELF POTENTIAL	49	510,170.0
SHORT NORMAL	33	374,006.0
TOTALS FOR GALVESTON COUNTY	235	2,515,010.0

MATAGORDA COUNTY

CURVE TYPE	CURVE COUNT	CURVE FEET
AMPLIFIED SHORT NORMAL	1	10,082.0
INDUCTION (CONDUCTIVITY)	1	10,082.0
INDUCTION (RESISTIVITY)	1	10,082.0
SELF POTENTIAL	1	10,082.0
SHORT NORMAL	1	10,082.0
TOTALS FOR MATAGORDA COUNTY	5	50,410.0

HIDALGO COUNTY

CURVE TYPE	CURVE COUNT	CURVE FEET
ACOUSTIC COMPENSATED	1	11,186.0
ACOUSTIC NON-COMPENSATED	1	5,008.0
CALIPER	2	16,194.0
GAMMA RAY (API UNITS)	1	11,186.0
SELF POTENTIAL	2	16,194.0
TOTALS FOR HIDALGO COUNTY	7	59,768.0

Subtask 3

GGIS has developed software for selective extraction and plotting of information from digitized curves. Curves from adjacent wells may be plotted side by side for comparison. The plots bracket depths of interest selected by the user.

Additional software utilizes sand profile information to plot cross-sections and detailed regional distribution maps of sand percentages, thicknesses, etc.

Header data is processed thru several algorithms to produce plots of temperature and pressure gradients and estimates of top of geopressure.

Subtask 4

A program has been developed to establish a library of log analysis and graphics software which will perform detailed log analysis and plot the results of that analysis in both cross-section and distribution formats. A package which will perform these tasks for temperature, mud weight, sand count, salinity, porosity, permeability, and compaction is expected to be completed by the end of calendar year 1979. Individual target dates are indicated on the work plan on the following page. The o-----> lines indicate a period of debugging and refinement after completion of initial development.

A comprehensive progress report for the Geopressured Geothermal Information System was sent on October 3, 1978 to Mr. Keith Westhusing, Department of Energy, Washington, D.C. This document describes progress in design and development of the System.

GGIS WELL-LOG DATA BASE
Work Plan 10/1/78 - 10/31/79

APPENDIX A

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APPENDIX B

ATTENDED MEETINGS, LECTURES, AND PUBLIC ADDRESSES

During the previous contract period, members of the geothermal project staff have provided technical coordination and liaison between DOE, other federal agencies, and state and local governmental agencies, industrial groups, and research participants. This has been accomplished by the attendance of qualified staff members at various meetings, and through talks to state, county, civic, and professional organizations which express interest in the geothermal project. The following is a record of such meetings, listed in chronological order.

10/20-21/77 Berkeley, California

Review of well logging and testing procedures on test well, Brazoria County, Texas to Lawrence Berkeley Laboratories Well Testing Symposium. Attended by Dr. Myron Dorfman. Generated interest in project, and cooperation of LBL in our studies.

10/21/77 Houston, Texas

Brief members of Texas Coastal Marine Council on status of Geopressured Geothermal Research Project and plans for the future. Participants were Dr. Sally Lopreato, Dr. Don Bebout, Mr. Clif Drummond, and Dr. C. Dale Zinn.

10/28/77 Corpus Christi, Texas

Speech to the South Texas Chamber of Commerce on UT Geothermal Project. Speaker was Dr. Myron Dorfman. Served to interest citizens in development of energy project.

11/1-2/77 St. Louis, Missouri

Presented paper on Geopressured Geothermal Energy at American Gas Association. Paper presented by Dr. Richard Deller.

11/3-4/77 Alvin, Texas

Attended ERDA Industry Committee Workshop on Geopressured Geothermal Energy to discuss plans for well. Attended by Mr. Will Boyd.

11/4/77 Houston, Texas

Presented description of Gulf Coast Geopressured Geothermal Energy at DOE Workshop. Presented by Dr. Richard Deller and Dr. Don Bebout. Mr. Arthur Oberbeck spoke and participated in Legal Working Group Conference.

11/15-18/77 Lafayette, Louisiana

Attended and participated in Third Geopressured Geothermal Energy Conference. Delivering papers were Mr. Arthur Oberbeck, Mr. Tom Hill, Mr. Will Boyd, Dr. Tom Gustavson, Dr. Don Bebout, Dr. Robert Loucks, Dr. C. Dale Zinn, and Dr. Myron Dorfman. Also attending were Dr. Richard Deller and Dr. John Vanston.

12/5-7/77 Santa Fe, New Mexico

Dr. Myron Dorfman served as Chairman of the Geothermal Resources Committee at the Interstate Oil Compact Commission. Presented national program on geothermal energy.

12/9/77 Austin, Texas

Update of UT Geothermal Project to the Texas General Land Office director and staff. Attended by Dr. Don Bebout, Dr. C. Dale Zinn, Dr. Richard Deller, Dr. Myron Dorfman, Mr. Tom Hill, Dr. Tom Gustavson, Mr. Arthur Oberbeck, and Mr. Will Boyd.

12/12/77 Houston, Texas

Speech at the Geothermal Resources Council Seminar on geothermal energy. Participant was Dr. Don Bebout. He also spoke on the current status of research in geopressured geothermal energy for the Special Short Course #6 "Geothermal Resources: Survey of an Emerging Industry."

12/15/77 Wichita Falls, Texas

Attended the North Texas Geological Society Noon Luncheon, to review geopressured geothermal resource assessment and site selection. Participant was Dr. Don Bebout.

12/20-21/77 Houston, Texas

Meeting between DOE personnel and General Crude Oil Co. Reviewed and formulated plans for drilling well. Attended by Mr. Will Boyd.

1/11-12/78 Washington, D.C.

Met with Dr. James Bresee (Director of Geothermal Division, DOE), Mr. William Hulls (Secretary of Natural Resources, LA), Chairman Mack Wallace (Texas Railroad Commission), Ms. Janice Gregory (Jake Pickle's Legal Assistant), Dr. John Andeline (Staff-Director of House Science Committee) - Formulated plans for Operations Research Program of UT Geopressured Geothermal Research Program. Attended by Mr. Clif Drummond and Dr. C. Dale Zinn.

1/19/78 Austin, Texas

Participated in committee with Fred Young and Mel Waxler of the Railroad Commission concerning legislative recommendations to be made to Chairman Wallace on geothermal legal issues. Participant was Mr. Arthur Oberbeck.

1/19-20/78 Danbury, Texas

Speech to organization of mayors and city council members in regards to Geopressed Energy in Brazoria County. Participant was Dr. C. Dale Zinn.

2/14-15/78 Houston, Texas

To evaluate a well-log digitizing system at Datashare International Ltd. Participants were Mr. Tom Hill and Mr. Robert Collins.

2/14/78 Houston, Texas

Attended seminar on Geothermal Energy at Rice University - Discussed well to be drilled. Participant was Mr. Will Boyd.

2/14/78 Houston, Texas

Public Address sponsored by the Energy Research and Education Foundation and Rice University. Title of address: "Testing Energy Potential of Deep Geopressed Geothermal Zones of Texas - Geology." Speaker was Dr. Don Bebout.

2/16/78 Dallas, Texas

Presentation to the Texas Environmental Coalition concerning geopressed geothermal project. Participant was Dr. Myron Dorfman.

2/21-22/78 Houston, Texas

Attended second meeting of DOE/Industry, Legal and Institutional Working Subgroup of the geopressed resource development program. Attended by Mr. Arthur Oberbeck.

2/23-24/78 Houston, Texas

Attended State Bar of Texas Environmental Law Institute. Participant was Mr. Arthur Oberbeck.

2/22-23/78 Galveston, Texas

Presentation to the Texas Water Conservations annual meeting to review drilling plans for the Brazoria County test well. Presentation made by Dr. Myron Dorfman.

2/24/78 Austin, Texas

Presentation at Earth Science Teacher's Day at Stephen F. Austin High School. Dr. Myron Dorfman made presentation to acquaint school teachers throughout the state with the geothermal project.

2/28/78 Midland, Texas

Addressed the Southwest Section of American Association of Petroleum Geologists, sponsored by the West Texas Geological Society. Title of address: "Geopressured Geothermal Energy from the Gulf Coast Frio Formation." Speaker was Dr. Don Bebout.

3/2-3/78 Houston, Texas

Conference with General Crude Oil Co. and United Gas Pipeline personnel regarding Geopressured Geothermal Project. Attended by Dr. C. Dale Zinn.

3/8/78 Waco, Texas

Addressed the Geology Department of Baylor University on the Geopressured Geothermal Resources of the Texas Gulf Coast, and the Lower Cretaceous Carbonates - South Texas. Speaker was Dr. Don Bebout.

3/9-10/78 New Orleans, Louisiana

Attended Southwest Engineering Research Council and confer with Louisiana, Texas, and DOE personnel in relation to Operations Research Contract at the request of Mack Wallace, Chairman of Texas Railroad Commission. Participants were Dr. C. Dale Zinn and Dr. Myron Dorfman.

3/20-21/78 Washington, D.C.

Presented Quarterly Review of Geopressured Operations Research Project for Texas and deliver proposal to DOE-DGE for continuing OR Project. Attended by Dr. C. Dale Zinn.

3/20-21/78 Houston, Texas

Presented results of Environmental Programs for Geopressured Geothermal Energy Studies by UT to the Texas Coastal Marine Council. Participant was Dr. Robert Loucks.

3/29/78 Austin, Texas

Briefing for Dr. Eric Willis, Mr. Rudy Black, Mr. DiBona, and Mr. Westhusing, Department of Energy, Washington, D.C. Department of Energy Officials were briefed by:

Dr. Walker, President, UT System

Dr. Rogers, President, UT Austin

Chairman Mack Wallace, Texas Railroad Commission

Mr. Bob Draper, V.P., General Crude Oil Co.

Mr. Fred Repper, V.P., Central Power & Light Co.

plus members of the UT geothermal group. Everyone agreed that the interchange between state government, industry, and university was a significant achievement in Texas, and geared toward early determination of feasibility of geopressured resources.

4/7/78 Austin, Texas

Presentation to DOE and Office of Management and Budget members regarding progress of geothermal research. Attended by Dr. Myron Dorfman and Dr. C. Dale Zinn.

4/11/78 Oklahoma City, Oklahoma

Address to the American Association of Petroleum Geologists Annual Convention. Title: "Deltaic Depositional Style in Salt - Withdrawal Basin, Frio Formation, Brazoria County, Texas." Speaker was Dr. Don Bebout.

4/14/78 Houston, Texas

Meeting to discuss setting up Geothermal Information Conference with representatives of Houston Lighting & Power, United Gas Pipeline, Transco and General Crude Oil. Attended by Dr. C. Dale Zinn.

4/20/78 Dallas, Texas

Meeting to receive and select abstracts for a session on geopressure at SPE Annual Meeting. A session on geopressure was presented at the SPE annual meeting. Dr. Dorfman chaired the session and Mr. Keith Westhusing, DOE, served as co-chairman.

4/21/78 Dallas, Texas

Meeting with the SPE Distinguished Lecturer Committee to plan itinerary for Lecturer for 1978-79 and to give orientation to Dr. Dorfman who will make the tour. Itinerary outlined for Distinguished Lecturer to make some 25 presentations in the United States as well as Europe, Africa, Alaska and Hawaii. Presentation to be entitled "Evaluation of Geopressured Resources in the U.S. Gulf Coast Basin."

4/25/78 Houston, Texas

Speech at the Southern Gas Association on the Geopressured Geothermal Project to management representatives of the gas industry. Keynote speaker was Dr. Myron Dorfman.

5/10/78 Austin, Texas

Attended EPA sponsored conference on controlling underground injection of liquid wastes. Participant was Mr. Arthur Oberbeck.

5/18-19/78 Houston, Texas

Attended American Bar Association National Institute on the National Energy Policy and the environmental barriers to energy development. Participant was Mr. Arthur Oberbeck.

5/23/78 Austin, Texas

Address by Dr. Myron Dorfman at the Geothermal Symposium Banquet concerning the UT Geothermal project.

6/1/78 Washington, D.C.

Participated in seminar on Geopressed Gas Resources conducted by the American Gas Association. Attended by Mr. Will Boyd.

6/6-8/78 Washington, D.C.

Met with Mr. Bennie DiBona, Assistant Director of Geothermal Division, DOE, Jake Pickle, and Bob Gammage about plans for test well and professional staff of congressional committee relative to support for UT Research Program in DOE FY 79 budget. Attended by Mr. Clif Drummond.

6/8/78 Austin, Texas

Speech to the Nuclear Science Symposium for high school students. Speaker was Dr. Myron Dorfman.

6/13/78 El Paso, Texas

Henry Dunlap represented Dr. Dorfman at the Society of Professional Well Logging Analysts Annual Meeting to obtain the latest information to be used in logging interpretations for Brazoria County well.

6/13/78 Arlington, Virginia

Speech to the American Gas Association Seminar on Geopressured Gas Resources. Speaker was Dr. Myron Dorfman.

6/15/78 Austin, Texas

General briefing to the Public Service Company of Oklahoma, Denver office by Dr. Myron Dorfman, Dr. Don Bebout, and Dr. C. Dale Zinn concerning the geothermal program activities. This meeting resulted in funding for the resource utilization section by Central and Southwest Corporation.

6/19-24/78 Taos, New Mexico

Attended Electric Power Research Institute's Second Geothermal Conference & Workshop. Also visited sites of potential geothermal resources in New Mexico, Jemez Caldera, and Jemez Hot Sulfur Springs. Attended by Dr. Richard Deller and Dr. Myron Dorfman.

6/27/78 Pearland, Texas

Address to the Rotary Club of Pearland on the progress of the Brazoria County test well. Speaker was Dr. Don Bebout.

6/27/78 Aspen, Colorado

Attended American Gas Association Institute Workshop entitled "R & D Priorities and the Gas Energy Option." Dr. Myron Dorfman served as discussion leader on the subject of gas production from geopressured aquifers at the session held 6/27/78. Informed workshop participants of another alternative source of unconventional gas supply.

7/7/78 Brazoria County Well Site

Attended the Brazoria County well site for DOE/GCO Pleasant Bayou #1 dedication ceremony. Speeches given by Dr. Eldon Sutton,

Vice President for Research at UT Austin, Dr. Herbert Woodson, Director of the Center for Energy Studies, Dr. Don Bebout from the Bureau of Economic Geology, and Dr. Myron Dorfman, Director for Geothermal Studies. Attended by Dr. Richard Deller, Dr. Parker Lamb, Mr. Clif Drummond, and Mr. Will Boyd.

7/12/78 Chicago, Illinois

Dr. Myron Dorfman served as a panelist on the Gas Research Institute Coordination Panel.

7/13/78 Arlington, Virginia

Address to the American Gas Association Seminar on Geopressured Gas Resources. Dr. Dorfman presented a paper entitled "Evaluation of Geopressured Aquifers in the U.S. Gulf Coast." Mr. Will Boyd served as a panelist at this meeting.

7/17/78 Houston, Texas

Delivered talk at meeting of Legal/Institutional Working Subgroup of DOE/Industry Geopressured Geothermal Development Program. Subject: Potential problems and opportunities for development program in Texas. Talk given by Mr. Arthur Oberbeck.

7/19/78 Dallas, Texas

Attended meeting sponsored by Department of Energy and conducted by Mathematica Policy Research, Inc. Purpose of the meeting was to update DOE on ways to expedite research in unconventional gas (geopressured geothermal resources). Participant was Dr. Don Bebout.

7/27/78 Austin, Texas

Speech to the West Austin Rotary Club at Westwood Country Club, to inform the public of current research in energy solutions. Presented by Dr. Richard Deller.

8/3-4/78 Las Vegas, Nevada

Attended Department of Energy sponsored meeting at their Nevada Operations Office of the Gruy "Wells of Opportunity" Program as a member of the Program Technical Committee in connection with Bureau of Economic Geology and Center for Energy Studies geothermal research funded by the Department of Energy. Participant was Dr. Don Bebout.

8/10/78 College Station, Texas and Beaumont, Texas

Talked with representatives of Texas A & M University concerning the geothermal project. Traveled to Beaumont to talk with Al Naylor at Gulf States Utilities on the geothermal project. Participant was Dr. William Lesso.

9/5/78 Ventura, California

Noon luncheon address to the California Coastal Section of the Society of Petroleum Engineers of AIME as a Distinguished Lecturer. Title of address: "Evaluation of the Geopressured Resources in the Texas Gulf Coast." Speaker was Dr. Myron H. Dorfman.

9/6/78 San Diego, California

Noon luncheon address to the San Diego Energy Forum sponsored by the Society of Petroleum Engineers of AIME. Title of address: "Evaluation of the Geopressured Resources in the Texas Gulf Coast." Dr. Myron H. Dorfman spoke as a Distinguished Lecturer.

9/7/78 Fullerton, California

Noon luncheon address to the L.A. Production Research Group. Title of address: "Evaluation of the Geopressured Resources in the Texas Gulf Coast." Dr. Myron H. Dorfman spoke as the Society of Petroleum Engineers of AIME Distinguished Lecturer.

9/13/78 San Antonio, Texas

Noon luncheon address to the South Texas Geological Society.

Title of address: "Geopressured Geothermal Resources - Frio Formation, Texas Gulf Coast." Speaker was Dr. Don Bebout.

9/19/78 Washington, D.C.

Speech to the Society of Petroleum Engineers of AIME as a Distinguished Lecturer. Title of address: "Evaluation of the Geopressured Resources in the Texas Gulf Coast." Speaker was Dr. Myron H. Dorfman.

9/20/78 New York City, N.Y.

Speech to the Society of Petroleum Engineers of AIME as a Distinguished Lecturer. Title of address: "Evaluation of the Geopressured Resources in the Texas Gulf Coast." Speaker was Dr. Myron H. Dorfman.

10/2-3/78 Victoria, Texas

Speech to ASME Coastal Bend Section about Geothermal Energy. This also will provide technical briefing on the UT research program. Participant was Dr. C. Dale Zinn.

10/1-4/78 Houston, Texas

Attended 53rd Annual Society of Petroleum Engineers Technical Conference and chaired the Technical Session for presentation and exchange of geopressured geothermal information relevant to present research underway at the Center for Energy Studies. Grants and contracts result from such exchanges and permit research to continue. Participants were Dr. Myron Dorfman, Dr. Don Bebout, and Dr. C. Dale Zinn. Dr. Zinn gave a speech on "Economics of Producing Geothermal Energy." Dr. Bebout spoke on "Evaluation of an Energy Resource - Geopressured Geothermal Zone, Texas Gulf Coast."

10/9/78 Houston, Texas

Address to the Geopressed Geothermal Industrial Advisory Committee, sponsored by the Texas Railroad Commission. Title of address: Exploration for Geopressed Geothermal Energy - A Progress Report." Speaker was Dr. Don Bebout. Dr. Myron Dorfman also attended.

10/10/78 Tyler, Texas

Speech to the East Texas Section of the Society of Petroleum Engineers of AIME as a Distinguished Lecturer. Title of address: Evaluation of the Geopressed Resources in the Texas Gulf Coast." Speaker was Dr. Myron H. Dorfman.

10/11/78 Olney, Illinois

Speech to the Illinois Basin Section of the Society of Petroleum Engineers of AIME. Title of address: "Evaluation of the Geopressed Resources in the Texas Gulf Coast." Dr. Myron H. Dorfman spoke as a Distinguished Lecturer.

10/24/78 Tulsa, Oklahoma

Noon luncheon address to the Tulsa Geological Society. Title of address: "Geopressed Geothermal Energy - Texas Gulf Coast." Speaker was Dr. Don Bebout.

11/7-9/78 Baton Rouge, Louisiana

Attendance at Seminar at LSU which considered legal problems inherent in geothermal resource development. Attended by Dr. C. Dale Zinn, Mr. Arthur Oberbeck, and Mr. Lewis Jones.

11/14/78 Dewitt, Michigan

Speech to the Society of Petroleum Engineers of AIME as a Distinguished Lecturer. Title of address: "Evaluation of the Geopressured Resources in the Texas Gulf Coast." Speaker was Dr. Myron H. Dorfman.

11/15/78 Chicago, Illinois

Speech to the Society of Petroleum Engineers of AIME. Title of address: "Evaluation of Geopressured Resources in the Texas Gulf Coast." Dr. Myron H. Dorfman spoke as a Distinguished Lecturer.

11/15/79 Omaha, Nebraska

Speech to the Society of Petroleum Engineers of AIME as a Distinguished Lecturer. Title of address: "Evaluation of the Geopressured Resources in the Texas Gulf Coast." Speaker was Dr. Myron H. Dorfman.

SOCIETY OF PETROLEUM ENGINEERS OF AIME
Distinguished Lecturer Critique Form

NOTE: Please return this form to:
Local Section Coordinator
Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, Texas 75206

Name of Lecturer: DR. MYRON H. DOREMAN

Subject: "Evaluation of the Geopressured Resources of the United
States Gulf Coast"

Section: California Coastal Section

Approximate Attendance: _____

Date of Meeting: September 5, 1978

EVALUATION OF LECTURE

NOTE: This evaluation should reflect the composite views of several officers or members of the local section who heard the lecture. Please evaluate the following items concerning the lecture:

Quality of Oral Presentation: Good Speaker

Content of Lecture: Good; accurate

Use of Audio-Visual Aids: Very Good

Suggestions for Improving Content of Lecture: None

Suggestions for Improving Oral Presentation: None

Additional Comments: Excellent speaker; knows his subject well;
interesting and effective delivery.

Society of Petroleum Engineers of AIME

6200 NORTH CENTRAL EXPRESSWAY • DALLAS, TEXAS 75206 • (214) 361-6601 • TELEX 730989

September 14, 1978

Professor Myron H. Dorfman
Petroleum Engineering Bldg. 211
University of Texas at Austin
Austin, Texas 78712

Dear Professor Dorfman:

On behalf of the Production Research Group of the Los Angeles Basin Section of the Society of Petroleum Engineers, I want to thank you for your excellent presentation to our group on September 7, 1978.

Your discussion on the geopressed resources of the U.S. Gulf Coast was of interest to our research-oriented group as exhibited by the large turnout. I wish you continued success on the remainder of your SPE Distinguished Lecturer tour.

Thanks again for a fine presentation.

Sincerely,

A handwritten signature in cursive script that reads "Brent Davenport".

Brent Davenport
Program Chairman

SOCIETY OF PETROLEUM ENGINEERS OF AIME
Distinguished Lecturer Critique Form

NOTE: Please return this form to:
Local Section Coordinator
Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, Texas 75206

Name of Lecturer: Prof. Myron H. Dorfman
Subject: Evaluation of the Geopressured Resources of the U.S. Gulf Coast
Section: Production Research Group / L.A. Basin Section
Approximate Attendance: 35
Date of Meeting: 9/7/78

EVALUATION OF LECTURE

NOTE: This evaluation should reflect the composite views of several officers or members of the local section who heard the lecture. Please evaluate the following items concerning the lecture:

Quality of Oral Presentation: Very good, except that he
spoke softly at times, so that some had trouble hearing
Content of Lecture: Excellent (very good technically)

Use of Audio-Visual Aids: Good

Suggestions for Improving Content of Lecture: None

Suggestions for Improving Oral Presentation: _____

Additional Comments: _____

SOCIETY OF PETROLEUM ENGINEERS OF AIME
Distinguished Lecturer Critique Form

NOTE: Please return this form to:
Local Section Coordinator
Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, Texas 75206

Name of Lecturer: Myron H. Dorfman
Subject: Evaluation of the Geopressed Resources of the U. S. Gulf Coast
Section: New York
Approximate Attendance: 17
Date of Meeting: September 20, 1978

EVALUATION OF LECTURE

NOTE: This evaluation should reflect the composite views of several officers or members of the local section who heard the lecture. Please evaluate the following items concerning the lecture:

Quality of Oral Presentation: (We did not provide mike.) Tended to address front
section of audience and did not reach back section.

Content of Lecture: Excellent; penetrated to proper depth of subject matter.

Use of Audio-Visual Aids: Excellent

Suggestions for Improving Content of Lecture: None; adapted very well to New York
Section interests.

Suggestions for Improving Oral Presentation: Speak to last man in audience (redundant
suggestion to university professor?).

Additional Comments: Unfortunate that this lecture was the first of the year, such that
media notices were not put out to attract larger audience for New York financial interests.

TRK

NEW YORK PETROLEUM SECTION
SOCIETY OF PETROLEUM ENGINEERS OF AIME

September 21, 1978

Dr. Myron H. Dorfman
The University of Texas at Austin
Department of Petroleum Engineering
Austin, Texas 78712

Dear Myron:

We enjoyed your "very" distinguished lecture September 20. The topic and your presentation were both excellent starts to our 1978/79 season of programs. We send our thanks, and only hope the remainder of the year's programs can measure up to this start.

Regards,

R. Sam Lyons
Program Chairman

RSL:ln

ASHLAND OIL, INC. • POST OFFICE BOX 391 • ASHLAND, KENTUCKY • 41101 • PHONE (606) 329-3333

J. D. HUGHES

Executive Vice President
Ashland Oil International
Washington, D. C.

REPLY TO:

Suite 507
1025 Connecticut Avenue, N.W.
Washington, D.C. 20036
Telex: 89-7419
(202) 223-8290

Dr. Myron H. Dorfman
Associate Professor
Department of Petroleum Engineering
University of Texas
Petroleum Engineering Building No. 211
Austin, Texas 78712

September 21, 1978

Dear Myron:

On behalf of the National Capital Section, S.P.E., Washington, D.C., I thank you for your excellent presentation. Many members came to me following the meeting, and expressed how well they enjoyed your talk.

It was also enjoyable for me to talk with you prior to our meeting. I was surprised that you are an old friend of Guido Piggott.

Next time that you are in the Washington, D.C. area, I hope you will take time to phone or visit.

Cordially yours,

A handwritten signature in dark ink, appearing to read "J.D. Hughes", written in a cursive style.

J.D. Hughes

UNION CARBIDE CORPORATION
CHEMICALS AND PLASTICS

P. O. BOX 186
PORT LAVACA, TEXAS 77979

October 11, 1978

Dr. C. Dale Zinn
Center for Energy Studies
Engineering Science Bldg.
University of Texas
Austin, TX 78712

Dear Dr. Zinn:

On behalf of the Coastal Bend Subsection of ASME, I would like to thank you for speaking on the topic of Geopressure Research.

As several members mentioned in our meeting, we certainly would enjoy having you speak again to discuss the Brazoria project after its completion.

Thank you again.

Very truly yours,

G. W. Burke
Acting Program Chairman

GWB:ds

SOCIETY OF PETROLEUM ENGINEERS OF AIME
Distinguished Lecturer Critique Form

NOTE: Please return this form to:
 Local Section Coordinator
 Society of Petroleum Engineers
 6200 N. Central Expressway
 Dallas, Texas 75206

Name of Lecturer: DR MURIN H. DORFMAN
 Subject: GEOPRESSURED-GEOTHERMAL RESOURCES IN GULF COAST
 Section: MICHIGAN SECTION
 Approximate Attendance: 45
 Date of Meeting: 11-14-78

EVALUATION OF LECTURE

NOTE: This evaluation should reflect the composite views of several officers or members of the local section who heard the lecture. Please evaluate the following items concerning the lecture:

Quality of Oral Presentation: EXCELLENT

Content of Lecture: COVERED THE GEOPRESSURED-GEOTHERMAL RESOURCES THAT IS PRESENTLY BEING DEVELOPED AND WHERE ADDITIONAL INTEREST LIES

Use of Audio-Visual Aids: SLIDE PRESENTATION

Suggestions for Improving Content of Lecture: NONE

Suggestions for Improving Oral Presentation: NONE

Additional Comments: MR DORFMAN IS A VERY FINE SPEAKER. HAD THE ATTENTION OF HIS AUDIENCE AT ALL TIMES

SOCIETY OF PETROLEUM ENGINEERS OF AIME
Distinguished Lecturer Critique Form

NOTE: Please return this form to
 Public Relations Dept., Society of
 Petroleum Engineers, 6200 N. Central
 Expressway, Dallas, Texas 75206

Name of Lecturer: Myron H. Dazman
 Subject: "Evaluation of Geopressured Resources of U.S. Gulf Coast"
 Section: Chicago
 Approximate Attendance: 40
 Date of Meeting: Nov 15, 1978

EVALUATION OF LECTURE

NOTE: This evaluation should reflect the composite views of several officers or members of the local section who heard the lecture. Please evaluate the following items concerning the lecture:

Quality of Oral Presentation: Excellent

Content of Lecture: Detailed

Use of Audio-Visual Aids: Good

Suggestions for Improving Content of Lecture: None - perhaps too detailed

Suggestions for Improving Oral Presentation: None - very good

Additional Comments: Detailed Subject presented well - covered a lot of ground.

APPENDIX C

DRILLING REPORT

"GCO-DOE PLEASANT BAYOU NO. 1"

<u>DATE</u>	<u>DEPTH FOOTAGE</u>	<u>REMARKS</u>
		Road and location preparation
06-30-78		Final rig up, started drive 26" conductor pipe
07-01-78	100'	Nippling up, mix mud
07-02-78	230'	Final NU, picked up DC, 24" 4-way DB
07-03-78	833'	Drilling 24" hole
07-04-78	1200'	Drilling 24" hole
07-05-78	1323'	Attempted run electric log, hole bridged, broke 6" x 6" x 8" bit blade
07-06-78	1323'	Fishing-ran magnet, no recovery, ran 24" underreamer
07-07-78	1323'	Reaming @ 1180'-Preparation for Dedication Ceremony
07-08-78	1323'	Reamed & conditioned hole-RA bullets 110'-1300'
07-09-78	1323'	RU & RU 20" casing, 1319' cement 1500 sx
07-10-78	1393'	WOC & NU 20" BOP, preparation drilling 17 1/2"
07-11-78	1393'	Rn 17 1/9" RB-tested BOP-drilling shoe
07-12-78	1997'	Sand & shale, 12 1/4" hole. Mud 9.1/43/12.6cc
07-13-78	2427'	Made 430', drilling. Mud 9.0/45/12.9cc
07-14-78	2784'	Made 357', drilling. Mud 9.0/43/17.6cc
07-15-78	3254'	Made 470', drilling. Mud 9.1/42/14.4
07-16-78	4077'	Made 872', drilling. Mud 9.1/42/14.4
07-17-78	4350'	Made 273', drilling to 4300', cored 4300'-50'
07-18-78	4770'	Made 420', drilling. Rec. 10' core. Mud 9.0/38
07-19-78	5238'	Made 468', drilling. Mud 9.1/43/14.8
07-20-78	5695'	Made 457', drilling. Mud 9.1/41/14.4

Drilling Report
GCO-DOE Pleasant Bayou No. 1

<u>DATE</u>	<u>DEPTH FOOTAGE</u>	<u>REMARKS</u>
07-21-78	6442'	Made 747', drilling sand & shale. 9.1/41
07-22-78	6700'	Made 258', drilling sand & shale
07-23-78	6750'	Made 50', cored 6700'-50', Rec. 8'
07-24-78	7171'	Made 421', drilling sand & shale
07-25-78	7438'	Made 267', drilling sand & limey shell
07-26-78	7864'	Made 426', drilling sand, shale & siltstone
07-27-78	8330'	Made 466', drilling sand, shale & siltstone
07-28-78	8478'	Made 148', drilling to 8478'--preparing to log.
07-29-78	8478'	No hole. Rn Dresser Elec. Logs. DIFL, & BHC Sonic, Caliper, Coup. Neutron, Densilog & Gamma Ray. Shot 50 SWC, Rec. 30.
7-30-78	8478'	No hole. Rn SWC, shot 16. Rec. 4. Rn Temp survey. Laid down 237 joints D. P.
7-31-78	8478'	Reamed 17 1/2" hole 1319'-2311'.
8-01-78	8478'	Reamed 17 1/2" hole 2311'-3827'. Mud 9.7
8-02-78	8478'	Reamed 17 1/2" hole 3827'-4356'. Mud 9.7
8-03-78	8478'	Reamed 17 1/2" hole 4356'-5347. Mud 9.9
8-04-78	8478'	Reamed 17 1/2" hole 5347-6656. Mud 9.8
8-05-78	8478'	Reamed 17 1/2" hole 6656-7095. Mud 9.8
8-06-78	8478'	Reamed 17 1/2" hole 7095-7870. Mud 9.8
8-07-78	8478'	Reamed 17 1/2" hole 7870'-8192'. Mud 9.9
8-08-78	8484'	Reamed 17 1/2" hole 8192'-8478'. Drilled 17 1/2" hole to 8484'. Mud 9.9
8-09-78	8484'	Ran Caliper Survey 8109'-1319'. Mud 9.9
8-10-78	8484'	Shot RA Bullets 8400'-1400'. Mud 9.9
8-11-78	8485'	Drilled 17 1/2" hole to 8485. Running 13 3/8" casing.

<u>DATE</u>	<u>DEPTH FOOTAGE</u>	<u>REMARKS</u>
8-12-78	8485'	Running 13 3/8" Casing. Laid down 13 joints.
8-13-78	8485'	Finished Running Casing. Cemented @ 8484
8-14-78	8485'	W.O.C. Now assembling BOP
8-15-78	8485'	Finished BOP assembly. Tested 4500 psi. Drilled 12 1/4"
8-16-78	8497'	Made 12'. Drilled cement and floatshoe, 12 1/4" bit. Pressure tested formation to 16.5% mud. Mud 9.9
8-17-78	8531'	Made 34'. Installed new swivel. Mud 10.0
8-18-78	8788'	Made 257'. Drilling 12 1/4" hole. Mud 10.7
8-19-78	8899'	Made 111'. Drilling. Changed bit. Mud 11.6
8-20-78	8994'	Made 95'. Round trip, check drill pipe. Mud 11.7
8-21-78	9240'	Made 256'. Drilling shale. Mud 11.6
8-22-78	9338'	Made 98'. Drilling to 9338'. Mud 11.6
8-23-78	9492'	Made 154'. Drilling sandy shale. Mud 12.0
8-24-78	9703'	Made 211'. Drilling shale. Mud 12.6
8-25-78	9792'	Made 88'. Drilling sandy shale. Mud 13.5
8-26-78	9859'	Made 67'. Drilling sandy shale. Mud 13.6
8-27-78	10029'	Made 170'. Drilling sandy shale. Mud 14.6
8-28-78	10135'	Made 106'. Drilling sandy shale. Mud 14.9
8-29-78	10215'	Made 80'. Drilling sandy shale and sand. Mud 14.9
8-30-78	10237'	Made 22'. Coring, sand. Mud 14.9
8-31-78	10270'	Made 33'. Shale and sand. Mud 14.7
9-01-78	10355'	Made 85'. Drilling shale. Mud 14.5
9-02-78	10446'	Made 91'. Drilling shale. Mud 14.5
9-03-78	10490'	Made 44'. Drilling sandy shale. Mud 14.5

<u>DATE</u>	<u>Depth FOOTAGE</u>	<u>REMARKS</u>
09-04-78	10601'	Made 111'. Drilling sandy shale. Mud 14.5
09-05-78	10664'	Made 63'. Drilling sandy shale. Mud 14.6
09-06-78	10775'	Made 111'. Drilling shale. Mud 15.1
09-07-78	10836'	Made 61'. Drilling sandy shale. Mud 15.3
09-08-78	10970'	Made 134'. Drilling sandy shale. Mud 15.2
09-09-78	11101'	Made 131'. Drilling sandy shale. Mud 15.3
09-10-78	11214'	Made 113'. Drilling sandy shale. Mud 15.4
09-11-78	11333'	Made 119'. Drilling sandy shale. Mud 15.6
9-12-78	11367'	Made 34'. Drilling sandy shale. Mud 15.6
09-13-78	11456'	Made 89'. Drilling sandy shale. Mud 15.7
09-14-78	11481'	Made 25'. Drilling sandy shale. Mud 15.7
09-15-78	11515'	Made 34'. Pulled out to change bit. Mud 15.7
09-16-78	11593'	Made 78'. Sandy shale. Repairing pump. Mud 16.0
09-17-78	11594'	Made 1'. Sandy shale. Fishing. Mud 16.0
09-18-78	11594'	No hole. Fishing. Recovered Casing Caliper.
09-19-78	11594'	No hole. Fishing. Unsuccessful run with fishing tool. Ran larger tool. Mud 16.0
09-20-78	11627'	Made 33'. Drilling sandy shale. Mud 16.0
09-21-78	11705'	Made 78'. Drilling sandy shale & sand. Mud 16.2
09-22-78	11737'	Made 32'. Coring sand and shale. Mud 16.3
09-23-78	11788'	Made 51'. Cored 56'. Rec 54'. Mud 16.3
09-24-78	11825'	Made 37'. Reamed & drilled sand & shale. Mud 16.3
09-25-78	11830'	Made 5'. Drill pipe stuck, fishing. Mud 16.0
09-26-78	11830'	No hole. Fishing, stuck drill pipe. Mud 15.8
09-27-78	11830'	Fishing. Top of fish 10605'. Mud 16.1
09 28-78	11830'	Fishing. Caught fish, pulling out. Mud 15.9
09-29-78	11830'	Recovered fish. Preparing drill ahead. Mud 15.7

<u>DATE</u>	<u>DEPTH FOOTAGE</u>	<u>REMARKS</u>
09-30-78	11830'	No hole. Rig repairs 24 hours. Mud 15.7
10-01-78	11857'	Made 27'. Found 150 fill. Drilling. Mud 15.7
10-02-78	11909'	Made 36'. Drilling. Changed bit. Mud 15.7
10-03-78	12000'	Made 91'. Drilling sand shale and siltstone. Mud 15.7
10-04-78	12061'	Made 61'. Drilling sandy shale and siltstone. Mud 15.7
10-05-78	12095'	Made 34'. Drilling sandy shale. Mud 15.7
10-06-78	12191'	Made 96'. Drilling sand, shale and siltstone. Mud 15.6
10-07-78	12260'	Made 69'. Drilling sandy shale and siltstone. Mud 15.6
10-08-78	12309'	Made 49'. Drilling sandy shale. Now tripping. Mud 15.5
10-09-78	12341'	Made 32'. Drilling sandy shale. Ran IE-S Log. Mud 15.5
10-10-78	12464'	Made 123'. Drilling sandy shale. Mud 15.4
10-11-78	12572'	Made 108'. Drilling sandy shale. Mud 15.2
10-12-78	12603'	Made 31'. Coring sandy shale. Mud 15.0
10-13-78	12631'	Made 28'. Cored sandy shale and shale. Mud 14.8
10-14-78	12676'	Made 45'. Drilling sandy shale. Mud 14.6
10-15-78	12776'	Made 100'. Drilling shale and sand. Mud 14.5
10-16-78	12817'	Made 41'. Drilling sand and sandy shale. Mud 14.5
10-17-78	12944'	Made 127'. Drilling shale sandstone, sand. Mud 14.1
10-18-78	12986'	Made 42'. Drilling sandy shale. Mud 13.8
10-19-78	13094'	Made 108'. Drilling sandy shale. Mud 13.8
10-20-78	13215'	Made 121'. Drilling sandy shale. Mud 13.8
10-21-78	13345'	Made 130'. Drilling sandy shale. Mud 13.8
10-22-78	13462'	Made 117'. Drilling sandy shale. Mud 13.8
10-23-78	13519'	Made 57'. Drilling sandy shale. Mud 13.8

<u>DATE</u>	<u>DEPTH FOOTAGE</u>	<u>REMARKS</u>
10-24-78	13633'	Made 144'. Drilling sandy shale. Mud 13.8
10-25-78	13830'	Made 167'. Drilling sandy shale. Mud 13.9
10-26-78	13976'	Made 146'. Drilling sandy shale. Mud 14.1
10-27-78	14053'	Made 77'. Sand. Prep. to core. Mud 14.1
10-28-78	14104'	Made 51'. Cored 14053'-104'. Sandy shale. Mud 14.1
10-29-78	14170'	Made 66'. Drilling sandy shale and sand. Mud 14.1
10-30-78	14337'	Made 167'. Drilling sandy shale. Mud 14.1
10-31-78	14484'	Made 147'. Drilled to 14484', well kicked, closed in pressure 80 psi. Mud 14.3.
11-01-78	14484'	No hole. Circulated, raised mud wt. to 14.9.
11-02-78	14573'	Made 89'. Drilling sand and sandy shale. Mud 15.3.
11-03-78	14677'	Made 164'. Drilling sandy shale. Mud 15.3
11-04-78	14745'	Made 68'. Preparing to run electric log. Mud 15.3.
11-05-78	14781'	Made 36'. Ran electric log. Cored 14745'-71'. Mud 15.3.
11-06-78	14807'	Made 26'. Drilling. Sand and sandy shale. Mud 15.3.
11-07-78	14890'	Made 83'. Drilling. Sand and sandy shale. Mud 15.3.
11-08-78	14984'	Made 94'. Drilling. Sand and sandy shale. Mud 15.3.
11-09-78	15133'	Made 149'. Drilled sand and sandy shale. Mud 15.3
11-10-78	15152'	Made 19'. Drilled to 15147'. Coring sand and sandy shale. Mud 15.2
11-11-78	15202'	Made 55'. Cored 55', recovered 40'. Sand and sandy shale. Mud 15.2.
11-12-78	15290'	Made 88'. Reamed core hole, drilling. Sand and sandy shale. Mud 15.2
11-13-78	15418'	Made 128'. Drilling. Sandy shale. Mud 15.2
11-14-78	15526'	Made 108'. Drilling sandy shale. Mud 15.3 <u>(CORRECTION)</u>

<u>DATE</u>	<u>DEPTH FOOTAGE</u>	<u>REMARKS</u>
11-14-78	15526'	Made 108'. Drilling sandy shale. Mud 15.3
11-15-78	15543'	Made 17'. Coring. Sandy shale. Mud 15.3
11-16-78	15595'	Made 52'. Cored 15543-95'. Shale and sand. Mud 15.3
11-17-78	15675'	Made 80'. Drilled to 15675'. Sand and sandy shale. Mud 15.3
11-18-78	15675'	No hole. Preparing to Core. Pipe stuck. Ran Free Point, Drill stem stuck 10505'. Mud 15.3
11-19-78	15675'	No hole. Backed off 10475' (WL) Ran Overshot and Jar Fishing Ass. Unable to catch Fish. Mud 15.3
11-20-78	15675'	No hole. Fishing. Top of Fish @ 10475' (WL). Unable to catch fish. Mud 15.3
11-21-78	15675'	No hole. Fishing. Ran guided tool joint pin to screw into fish. Well kicked. 15.3 mud closed BOP. Shut in drill pipe pressure 575. Weighting up. Mud 16.9
11-22-78	15675'	No hole. Fishing. Raised mud wt to 17.4. Fish- ing string at 5900' stuck in barite plug. Worked free. Circulated gas-cut mud, max chlorides 53,000 Mixing mud.
11-23-78	15675'	No hole. Fishing. Attempting circulate. Mud 16.0 Returns showed salt water and shale. Drill pipe at 5632'. No pressure on well.
11-24-78	15675'	No hole. Fishing. Attempting pull out. Mud 15.7 Mixed mud to build volume. Lost returns. Pulled pipe to 1300', well started flowing. Went back in hole to spot lost circulation material.
11-25-78	15675'	No hole. Fishing. Attempting circulate. Mud 15.5 Spotted mud with 42 lbs. lost circulation material per barrel.
11-26-78	15675'	No hole. Fishing. Circulating. Mud 15.5 Circulated with drill pipe at 4317'. Recovered large amount salt water and 16.3 mud. Went in hole to 7378'.
11-27-78	15675'	No hole. Fishing. Circulating. Mud 15.6 Returns showed gas-cut mud, 1000 units of gas, Cl 15,000 ppm. Pulled 64 stands of drill pipe, well started flowing. Went back to 7300'.

Drilling Report
GCO-DOE Pleasant Bayou No. 1

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<u>DATE</u>	<u>DEPTH FOOTAGE</u>	<u>REMARKS</u>
11-23-78	15675'	No hole. Fishing. Now out of hole. Mud 15.8. Circulated and conditioned mud to 15.6. Could not pull out of hole. Raised mud weight to 15.8. Pulled out.
11-29-78	15675'	No hole. Reaming hard black shale at 7853'. Found shale bridge 7682'. Top of fish 10,416'. Mud 15.8
11-30-78	15675'	No hole. Reamed hard black shale from 7853'-7960'. Washed to 8220'. Conditioned mud. Circulated out saltwater and gas-cut mud. Mud 15.8
12-01-78	15675'	No hole. Reamed and washed hole from 8220'-8530'. Circulated out saltwater and gas-cut mud. Conditioned mud. Mud 15.8
12-02-78	15676'	No hole. Fishing. Reamed and washed hole from 8530'-8765'. Circulated out black shale, saltwater, and gas-cut mud. Mud 15.8
12-03-78	15675'	No hole. Fishing. Reamed and washed hole from 8765'-8973'. Recovered black shale. Hole sloughed, stuck drill pipe, worked free. Mud 15.9
12-04-78	15675'	No hole. Fishing. Reamed and washed hole from 8973'-9050'. Round trip change bit. Mud 15.9
12-05-78	15675'	No hole. Fishing. Reamed and washed hole from 9050'-9342'. Hole sloughed, circulated out large amount black shale. Mud 15.9
12-06-78	15676'	No hole. Fishing. Reamed and washed 9342'-9536'. Hole sloughed at 9417'. Circulated out large amount black shale. Mud 15.9
12-07-78	15675'	No hole. Fishing. Reamed to 9554'. Set bridge plug 3424'. Pressured 13-3/8" casing. Found hole at 4211'-31'. Prepared to cement. Mud 15.9
12-08-78	15676'	No hole. Repairing 13-3/8" casing. Set bridge plug 4250'. Ran RTTS tool and squeezed 200 sacks cement into hole in 13-3/8" casing at 4211'. Mud 15.9
12-09-78	15675'	No hole. Repairing 13-3/8" casing. Tested squeeze job 500 psi. Drilled out bridge plug @ 4250', lost returns. Mud 15.9
12-10-78	15675'	No hole. Repairing 13-3/8" casing. Casing held 500 psi above 4246'. Drilled out bridge plug and pushed to 8470'. Mud 15.9

DRILLING AND COMPLETION PLANS FOR A GEOPRESSURED WELL

Introduction

Testing and sampling of geopressured formations can be best obtained from a hole drilled and completed specifically for a geothermal test. This will insure that the casing and tubing sizes are large enough for the flow volumes needed to exploit the resource and that the requisite testing-sampling devices can be run in the well. Actual fluid production tests must be conducted to measure the quality and quantity of heated water, thermal output and geohydraulic power under dynamic conditions, and the quantity of gas that can be obtained on a continuing basis. Short-term production tests may give an indication of fluid pressure and volume relationship, but flowing tests of a year or more may be needed to precisely evaluate porosity and permeability of a reservoir rock. Cores will be needed to predict actual mechanical strength of the rocks penetrated. Cored samples from the side-wall of the well can be taken by wireline methods; sidewall samples may be used for laboratory analysis to confirm lithology, porosity and original fluid content of the geopressured formations. After casing is set in a well, acoustic surveys can be used to determine the quality of cement and the bond between the pipe and wall of the hole. Shaped-charge explosives (jets) will be used to perforate the casing to permit formation fluids to enter the well bore; the perforations will be made at the most porous zones of the reservoir face in the hole, using radioactivity surveys for depth control. Radioactive markers (bullets) will be shot into the well bore at certain levels to be used as references for subsidence observations as the well is produced. Other wireline surveys will be run periodically to observe

bottomhole temperature, and pressure, to secure fluid samples, and for fluid flow data to evaluate reservoir performance.

Drilling Safeguards

More than 400 wells are being drilled annually for oil or gas to 15,000 feet or greater depth in the United States. About fifty of these reach 20,000 feet or more. Some 6,000 deep wells have been drilled in the U. S. during the past twenty years. Approximately 4,000 were located in the Gulf Coast area of Texas and Louisiana. Drilling machinery, tools and equipment for deep wells have been very much improved during this time and are considered quite satisfactory for the mechanical loads, pressures, and temperatures that will be encountered in 20,000-foot geothermal-geopressured wells. Rigs to handle 1,000,000-pound hook loads are working in the Gulf Coast and can be obtained for contract drilling. These rigs have 25-30 feet substructure height and the required blowout preventers for this kind of work. Casing and tubing, in the sizes, weights, and grades of steel needed for 20,000-foot wells are readily available — though delivery time for some sizes and grades may be lengthy. Related wellhead equipment, including high pressure valves and fittings, are available.

Materials are readily available for the 17-18 ppg (pound per gallon) muds required to contain the very high pressures found in formations. Mud expense is considerable for the specially treated, high density fluids needed; cost of mud materials for a 15,000-foot well may be \$200,000 (1976) or more. Blowout preventer equipment suitable for 5,000-10,000 psi pressure will be installed for protection against the high formation pressures that may be encountered while drilling. The production string of casing that will be set to complete the well will

be fitted with 10,000-15,000 psi working pressure equipment because of the possibility of high pressure gas at the wellhead. With a given bottomhole formation pressure of, say, 12,000 psi, shut-in pressure may be only 6,000 psi with a column of salt water extending to the surface, but with gas tubing pressure could exceed 10,000 psi.

Casing and blowout preventers are very important safeguards against "Kicks" and "Blowouts". Casing must be set and cemented to such depths as to provide a solid, pressure-tight, foundation for the wellhead and blowout preventers in case a high-pressured formation is drilled into. Although the drilling fluid normally provides sufficient hydrostatic head to overbalance and contain formation pressure, high pressure blowout preventers, wellhead and casing are needed to provide a safeguard in case excessive formation pressure is encountered while drilling. Blowout preventers, in such case, will make the difference between a kick, which is formation fluid or gas that is circulated out of the hole under controlled conditions, or a blowout, which is an uncontrolled flow of fluid or gas from a well. In the latter case, flow from the well becomes uncontrollable and the hazard of an explosion and fire is created.

Prediction and detection of geopressured formations is a fairly exact procedure today. Many of the parameters that indicate the proximity of high pressure can be measured within the time needed to circulate from the bottom of the well to the surface, about two hours on a deep hole. Continuous plots of mud temperature, fluid weight, cuttings density, and normalized drilling rates make it possible to anticipate dangerous high pressures by departures from straightline trends. Electric logs, from which formation resistivity, conductivity and shale density can be obtained, will give after-the-fact evidence that geopressured formations have been penetrated.

Geopressured Water Producer

Though few have been made specifically for the purpose, a geopressured water producer will generally have the same conditions and characteristics as oil and gas wells completed in geopressured formations. The holes will be deep, generally in the order of 15,000 feet, bottom hole pressure may be 12,000 psi or greater, and formation temperature 300°F or more. Pressure at the surface will not likely exceed 10,000 psi because a column of hot brine will lessen shut-in pressure and fluid friction losses will lower flowing pressures. High volume producers will require large diameter tubing and accessories to permit flow of large quantities of fluid without excessive pressure draw down. Table 1 shows calculated pressures at the wellhead for various sizes of tubing and flow rates with a given formation pressure and permeability. Since sand production must be negligible or zero for a viable geothermal-geopressured producer, regular wellhead equipment may be used, though this will not preclude downhole sand control procedures or sand detection equipment in the surface facility.

Wellhead Equipment

The wellhead for the proposed geopressured water well completion will be a 20" x 13 3/8" x 9 5/8" x 5 1/4", 15,000 psi working pressure assembly, generally as depicted in Figure 1. This head will be built up from a baseplate that will be landed on the cut-off stub of the conductor pipe that will be cemented in a shallow cellar, some three feet below the ground level. This will place the 20" flange about level with the ground surface.

Table 1

FLOWING WELLHEAD PRESSURES
VARIOUS SIZE TUBING

13,000 Ft Depth; 11,700 Psi Pressure, 5000 Md-Ft Permeability

Flow Rate Barrels/Day	Tubing Head Pressures (Psi)		
	<u>4 1/2-In Tbg.</u>	<u>5 1/2-In Tbg.</u>	<u>7-In Tbg.</u>
10,000	5800	6200	6290
20,000	4640	5550	5900
40,000	450	3600	4900
60,000	----	1000	3730

Figure 1. Casing Program for a Geopressured Geothermal Well.

Casing

Casing will be set in the proposed well generally as shown in Figure 2. Surface casing will be 20" size set in 24" diameter hole. Setting depth will be at 1100 feet, or as prescribed by state regulations. The 13 3/8" intermediate casing string will be set in 17 1/2" diameter hole, which will be drilled into the top of the transition zone from hydropressure to geopressures, above any possible sand that may contain excessive formation pressure. The 9 5/8" production casing will be set in 12 1/4" diameter hole immediately above the objective sands expected to be productive. Hole below the 9 5/8" casing setting depth will be 8 1/2" diameter for the 7" liner that will be set for production.

The 20" and 13 3/8" casing strings will be cemented to the surface. This will anchor these strings to prevent movement due to expansion when they are heated by hot fluid from the geopressured formations. It would be desirable to cement the 9 5/8" casing to the surface, but formation breakdown with high weight cement slurry may prohibit. The 9 5/8" casing strings will be landed at the surface in full tension in order to minimize compressive metal stress when heated. The 5 1/2" tubing string will be suspended at the surface in full tension.

Completion Planning

Notwithstanding that drilling of a well progresses from the surface to the bottom, engineered deep well planning is the reverse process, i.e., it starts at the bottom of the hole. After curves for both pore pressure and fracture gradient versus depth have been established, an ideal mud-weight curve can be plotted against depth. Geological, technical, safety and economic considerations will influence the size, setting depth, and design factors (burst, collapse, and tension) for the

Figure 2. 20" x $13 \frac{3}{8}$ " x $9 \frac{5}{8}$ " x $5 \frac{1}{2}$ " Wellhead Assembly.

production string that will be set in a geopressed formation. The production string, of course, must be large enough to accomodate the production tubing with reasonable clearance. The diameter of the production casing will determine the hole diameter at final depth, drill pipe size, hoisting loads, and other mechanical factors of drilling. The diameter and setting depth of the intermediate casing must be suitable for the final string of casing. Likewise, the diameter and setting depth of the surface casing must be appropriate for the intermediate string and the mud weight needed to reach the depth at which intermediate casing will be set. Weight of casing and tubing suspended at the wellhead will be one value under static conditions when the pipe string is at normal earth temperatures and quite another when high temperature fluids from the producing formation are flowed to the surface. If the tubing string is fixed both top and bottom severe buckling or tension stresses may develop with temperature changes. Unless the casing strings are solidly cemented bottom to top, increased temperatures will tend to lengthen the pipe and may cause the wellhead to rise; conversely lowered temperature could cause the pipe strings to shorten and thus impose tension stress at wellhead which may exceed tensile strength of the pipe and/or threaded joints.

Completion Operations

A geopressed well completion, after the hole is drilled, logged and tested to total depth, will commence with preparations to set and cement the production casing or liner. The usual first step is to clean out the open hole, condition the drilling fluid, and make sure that casing can be run to the bottom of the hole. Mud density should be high enough to provide about 300 psi overbalance of the highest formation

pressure exposed to the wellbore. Deep wells, where time off bottom may be excessive and fluid pressure fairly high opposite the lower pressured intervals, can be cased best by means of a liner. This procedure will insure minimum exposure time to high differentials that may stick the pipe.

The cement-to-hole and cement-to-pipe bonding should be checked by means of a cement bond log, thus to determine the effectiveness of the cement in the casing-formation annulus. A bond log will show the quality of the cement behind the casing, where gaps and channels in the cement sheath may exist, and the top of the cement in the annulus. Cement bond logs are usually run in conjunction with a gamma ray logging device that will record the lithology and depths of formation behind the casing. This will permit depth correlation with a similar log when perforating the casing. If necessary, cement gaps and/or channels behind the liner will be squeeze cemented to insure good cement bond between the liner and wall of the hole.

When the liner is satisfactorily cemented in the well and pressure tested, the liner will be cleaned out to the desired depth opposite the interval(s) to be perforated. Completion operations can then proceed to make the well ready as a producer. Successive steps to complete the well — not necessarily in the following sequence — will include perforating, running tubing and packer, displacing the old mud in the annulus with a specially prepared packer (completion) fluid, installation of tubing accessories, assembly of the tubing head, landing the tubing, and unloading the well.

Earlier practice was to perforate the well with the casing full of drilling mud to hold down formation pressure while recovering the perforating

tools and running tubing. Large diameter, casing-size, bullet or jet perforators were employed. After perforating the productive interval, tubing and packer were run, the tubing head attached to the casing head assembly, and the well brought into production by lightening the fluid column in the tubing. Usually, nearly all the perforations were plugged with mud. Modern practice favors perforating the pay zone with hydrostatic pressure in the wellbore less than formation pressure. This requires cleaning out the wellbore to the productive interval to be perforated and replacing the drilling mud with fluid that will cause less damage to the formation. Salt water is often used as a perforating fluid, but if formation pressure is considerable, heavyweight solids-free fluid such as calcium chloride or calcium bromide may be employed. After spotting special fluid at the interval to be perforated, the work string of pipe will be removed and a production packer set about thirty feet above the place in the casing that will be perforated. Tubing with a 20-foot long assembly of seal nipples to fit the packer bore will be run. Since pressure as high as 12,000 psi may be anticipated, special precautions will be taken to obtain absolutely "bubble-tight" tubing joints. Threads should be properly lubricated and carefully tightened to specific torque. The seal nipple is seated in the packer and spaced out at the tubing head to allow about 20-foot movement of the lower end as the string lengthens due to thermal expansion when hot fluids are flowed to the surface. The average temperature of the tubing string in a geopressured producer may vary as much as 150°F. This can cause 16-foot variation of tubing length in a 15,000-foot well with consequent stress on the threaded connections if the string is anchored at top and bottom.

Perforating Procedure

A high pressure lubricator will be rigged up on the swabbing valve of the Christmas Tree. The lubricator will be long enough to accommodate the maximum length perforating gun, with a hydraulic packing gland to lessen leakage around the perforating conductor cable, and a fitting for control fluid injection to seal pressure on the cable. The lubricator with gun assembly inside will be pressure-tested to 10,000 psi pressure before the gun is lowered into the well.

The perforating gun will be run with a collar-locator and gamma ray instruments for positive depth control relative to the zone of porosity to be perforated. The perforator should be a Hollow Carrier Jet gun, loaded four shaped-charges per foot, and fitted with spring-type deflection devices to insure centralization of the gun inside the casing. Regular charges for 3 3/8-in. and 4-in. hollow-carrier guns are suitable for 20,000 psi bottom hole pressure and 340°F temperature. If needed, high temperature powder can be obtained for 25,000 psi and 470°F. Gun length will be limited by the weight of the assembly and the lubricator length available. The gun should be loaded in such manner to perforate only the best intervals of porosity on the electric log.

Prior to firing the perforating charges, the tubing and lubricator should be raised to sufficient pressure, using salt water, to obtain an equivalent hydrostatic pressure at perforating depth about 300 psi less than formation pressure. For example, assuming 15,000-foot perforating depth with a full column of salt water in the well, hydrostatic pressure due to the salt water only will be 6600 psi at perforating depth. To raise this pressure to 11,200 psi — on the assumption that formation pressure is 11,500 psi — 4600 psi will be applied at the surface thus

to obtain the desired pressure at perforating depth. If penetration is obtained when the perforating charges are detonated there will be an immediate pressure increase at the surface, i.e., to 4944 psi. If this pressure is obtained, the perforating gun can be recovered and preparations made to perforate additional footage, or flow test the well, as may be in order. If more holes are needed, successive runs should be made with the perforator in the same manner. Fluid production for a given pressure drawdown will depend on the permeability of the sand and its thickness, i.e., or permeability-foot, usually expressed as millidarcy-feet. Fluid velocity through the perforations, as described below, will depend on the number of holes per foot (density), the net feet of perforated interval, and the fluid producing rate.

Perforating should be started at the lowest sand in the well and proceed upwards. This will enable successive perforating runs to be made at shallower depths. Since the well is ready to flow as soon as perforations are made, production tests can be made at any time after the first zone is opened to the well bore. When enough holes have been made to allow sufficient productive capacity, the well can be tested for fluid volume, drawdown pressure at the tubing head, and evidence of sand entry. If needed, additional holes per foot or added internal can be perforated without changing the tubing setting. This may be necessary to increase the rate of flow, to obtain higher pressure at the wellhead at maximum flow rate, or to reduce sand production caused by high velocity flow through the perforations. In general, fluid production should not exceed 100 barrels per day per foot of perforations. This volume can be obtained with flow velocity through each perforation not greatly exceeding one foot per second. Lower velocity can be obtained by opening

more holes per foot or by perforators that make larger openings in the casing. For example, 8 shots per foot, using shaped charges that make 3/8-inch holes, will enable 1.1 ft/sec. velocity through the perforations at 100 b/d flow rate. "Big-Hole" perforators, which create 0.90-inch holes, will have 0.38 ft./sec. velocity through four holes per foot for the same production rate per foot of perforations.

Sand Control

The best means of sand control for a geopressured water producer will be to increase the flow area across the face of the producing formation, thus to lower the drag force of the produced fluid to pull sand into the well. Good well completion practices must be employed:

- ° Properly cemented casing in the producing interval(s)
- ° Large diameter, clean perforations
- ° Bring well on production slowly

An open-hole gravel pack would be the preferred treatment, but will be difficult or impossible to perform on a geopressured well because of lost circulation and the requirement for expensive or unusual drilling fluid. Workover and cleanout would be particularly hazardous for an open-hole gravel pack. A perforated casing gravel-pack is much simpler to clean out and can be performed using gel-type fluid to reduce fluid loss into permeable sands. Plastic consolidation treatments are usually limited to short intervals, will not be effective where perforations are plugged, and the curing reaction is dependent on temperature. The cured plastics are subject to thermal degradation and decomposition.

APPENDIX E

(Not included in this printing)

APPENDIX F

WELL LOGS

FORM 925297

Dresser Atlas		Combination Logging Systems		Ø	
DRESSER		Dual Induction Focused Log		R	
BHC Acoustilog					
FILE NO.	COMPANY <u>GENERAL CRUDE OIL COMPANY</u> DEPT. OF ENERGY WELL <u>GCO-DOE PLEASANT BAYOU #1</u> FIELD <u>WILDCAT (CHOCOLATE BAYOU AREA)</u> COUNTY <u>BRAZORIA</u> STATE <u>TEXAS</u> LOCATION: * SEC _____ TWP _____ RGE _____				
Permanent Datum <u>MEAN SEA LEVEL</u> Elev. <u>11.0</u>		Other Services C-D/L-N. CALIPER DIFF. TEMP. SWC			
Log Measured from <u>KELLY BUSHING</u> <u>31.30</u> Ft. Above Permanent Datum		Elevations: KB <u>42.30'</u> DF <u>41.30'</u> GL <u>11.0'</u>			
Drilling Measured from <u>KELLY BUSHING</u>					
Date	<u>7-4-78</u>	<u>7-28-78</u>	<u>11-4-78</u>		
Run No.	<u>1-IEL</u>	<u>2-DIFL-A/L</u>	<u>**4-DIFL-A/L</u>		
Service Order		<u>03476</u>	<u>99575</u>		
Depth—Driller	<u>1323</u>	<u>8478</u>	<u>14,745</u>		
Depth—Logger	<u>1327</u>	<u>8478</u>	<u>14,758</u>		
Bottom Logged Interval	<u>1322</u>	<u>8476</u>	<u>14,756</u>		
Top Logged Interval	<u>101</u>	<u>1317</u>	<u>8488</u>		
Casing—Driller	<u>- @ 98</u>	<u>20 @1319</u>	<u>13-3/8@8481</u>	<u>@</u>	
Casing—Logger	<u>101</u>	<u>1317</u>	<u>8488</u>		
Bit Size	<u>24</u>	<u>12-1/4</u>	<u>12-1/4</u>		
Type Fluid in Hole	<u>SUPER COL LIME</u>	<u>LIGNOSULF</u>	<u>LIGNOSULF</u>		
Density and Viscosity	<u>8.9</u> <u>40</u>	<u>9.5</u> <u>38</u>	<u>15.3</u> <u>45</u>		
pH and Fluid Loss	<u>9.5</u> <u>18.6cc</u>	<u>10.5</u> <u>6.0cc</u>	<u>10.5</u> <u>2.4cc</u>	<u>cc</u>	
Source of Sample	<u>PIT</u>	<u>FLOWLINE</u>	<u>FLOWLINE</u>		
Rm @ Meas. Temp.	<u>4.38 @75 °F</u>	<u>1.15 @ 70 °F</u>	<u>0.64 @ 90 °F</u>	<u>@ °F</u>	
Rmf @ Meas. Temp.	<u>3.11 @75 °F</u>	<u>0.86 @ 70 °F</u>	<u>0.48 @ 90 °F</u>	<u>@ °F</u>	
Rmc @ Meas. Temp.	<u>5.29 @75 °F</u>	<u>1.44 @ 70 °F</u>	<u>0.80 @ 90 °F</u>	<u>@ °F</u>	
Source of Rmf and Rmc	<u>MEAS CALC.</u>	<u>CALC CALC</u>	<u>MEAS CALC</u>		
Rm @ BHT	<u>- @ °F</u>	<u>0.5 @158 °F</u>	<u>@ °F</u>	<u>@ °F</u>	
Time Since Circ.	<u>2 HRS</u>	<u>12 HRS</u>	<u>5 HRS</u>		
Max. Rec. Temp. Deg. F	<u>°F</u>	<u>158 °F</u>	<u>286 °F</u>	<u>°F</u>	
Equip. No. and Location	<u>6139 PEARL</u>	<u>6139 PEARL</u>	<u>6150 ALICE</u>		
Recorded By	<u>GUADRY</u>	<u>PERMENTER-BROWN</u>	<u>BUYS</u>		
Witnessed By	<u>MCGUFFIN-BULMBERG</u>	<u>KELLEY</u>	<u>FLARITY-MCGOFFYN</u>		

FOLD HERE

Remarks: *UNAVAILABLE

**ON 10-8-78 RECORDED RUN 3 (IEL) FROM 12308 TO 13-3/8" CSG. RUN FOUR (DIPL)

RE-RECORDED SECTION LOGGED ON RUN 3 & USED IN FINAL COMPOSITE. RUN 3

PRESENTED SEPARATELY

FORM 925145

<h1 style="margin: 0;">Induction Electrolog.</h1>	
FILE NO.	COMPANY <u>GENERAL CRUDE OIL COMPANY</u> DEPT. OF ENERGY WELL <u>GCO-DOE PLEASANT BAYOU #1</u> FIELD <u>WILDCAT (CHOCOLATE BAYOU AREA)</u> COUNTY <u>BRAZORIA</u> STATE <u>TEXAS</u>		
	LOCATION: * SEC _____ TWP _____ RGE _____		Other Services DIFL-A/L C-D/L-N TEMP. SWC
Permanent Datum <u>GROUND LEVEL</u> Elev. <u>11.0</u> Log Measured from <u>KELLY BUSHING 31.30</u> Ft. Above Permanent Datum Drilling Measured from <u>KELLY BUSHING</u>		Elevations: KB <u>42.30'</u> DF <u>41.30'</u> GL <u>11.0</u>	
Date	<u>10-8-78</u>		
Run No.	<u>**3</u>		
Depth—Driller	<u>12309</u>		
Depth—Logger	<u>12308</u>		
Bottom Logged Interval	<u>12302</u>		
Top Logged Interval	<u>8483</u>		
Casing—Driller	<u>13-3/8 @ 84</u>	@	@
Casing—Logger	<u>8483</u>		
Bit Size	<u>12.25"</u>		
Type Fluid in Hole	<u>MUD</u>		
	@	@	@
Density and Viscosity	<u>15.5 43</u>		
pH and Fluid Loss	<u>10.5 2.0cc</u>	cc	cc
Source of Sample	<u>TANK</u>		
Rm @ Meas. Temp.	<u>0.75@ 90 °F</u>	@ °F	@ °F
Rmf @ Meas. Temp.	<u>0.54@ 90 °F</u>	@ °F	@ °F
Rmc @ Meas. Temp.	<u>0.90@ 90 °F</u>	@ °F	@ °F
Source of Rmf and Rmc	<u>MEAS MEAS</u>		
Rm @ BHT	@ °F	@ °F	@ °F
Time Since Circ.	<u>10 HRS</u>		
Max. Rec. Temp. Deg. F.	°F	°F	°F
Equip. No. and Location	<u>6149 S'POR</u>		
Recorded By	<u>TOMPKINS</u>		
Witnessed By	<u>MCGUFFIN, FLARITY</u>		

THIS HEADING AND LOG CONFORMS TO API RECOMMENDED STANDARD PRACTICE RP-31

FOLD HERE ↓

Equipment Used	
Series No. <u>809</u>	Run No. <u>3</u>
S.O. <u>05345</u>	Tool No. <u>52</u>
	Elec. No. <u>21012</u>

REMARKS * UNAVAILABLE

** AT TIME OF RUN 4 INTERVAL RECORDED AS RUN 3

RERECORDED AS A DIFL & USED IN FINAL COMPOSITE

FORM 8252 (4-1)

Differential Temperature Log

FILE NO.	COMPANY <u>GENERAL CRUDE OIL CO. -</u>	
	DEPT. OF ENERGY	
	WELL <u>GCO-DOE PLEASANT BAYOU #1</u>	
	FIELD <u>WILDCAT (CHOCOLATE BAYOU AREA)</u>	
	COUNTY <u>BRAZORIA</u>	STATE <u>TEXAS</u>
LOCATION: <u>*</u>		Other Services
SEC _____ TWP _____ RGE _____		DIFL/BHC-AL GR/CNL/CDL SWC/CAL.

Permanent Datum GROUND LEVEL Elev. 11.0 KB 42.30'
 Log Measured from KELLY BUSHING 31.3 Ft. Above Permanent Datum DF 41.30'
 Drilling Measured from KELLY BUSHING GL 11.0'

Date	<u>7-29-78</u>
Run No	<u>1</u>
Type Log	<u>TEMPERATURE</u>
Depth-Driller	<u>8478</u>
Depth-Logger	<u>8478</u>
Bottom Logged Interval	<u>8477.5</u>
Top Logged Interval	<u>215</u>
Type Fluid in Hole	<u>LIGNOSULF.</u>
Salinity Ppm Cl.	
Density Lb /Gal.	<u>10.7</u>
Level	<u>FULL</u>
Max Rec Temp. Deg. F	<u>188</u>
Opr. Rig Time	<u>6 HRS</u>
Recorded By	<u>PERMENTER/BROWN</u>
Witnessed By	<u>KELLEY</u>

Run No.	Bore Hole Record			Casing Record			
	Bit	From	To	Size	Wgt.	From	To
1	12.25	1319	8478	20"		0	1319

Equipment Used

Series No.	1
Run No.	03476
SO.	
Tool No.	
Elec. No.	22222
Drilling No.	

REMARKS * UNAVAILABLE

FORM 025100

CALIPER LOG

FILE NO.	COMPANY		GENERAL CRUDE OIL CO. -	
			DEPT. OF ENERGY	
	WELL		GCCO-DOE PLEASANT BAYOU #1	
	FIELD		WILDCAT (CHOCOLATE BAYOU AREA)	
	COUNTY	BRAZORIA	STATE	TEXAS
	LOCATION: *		Other Services PERF/DIFI / CNL/CDL / TEMP/SWC /	
	SEC	TWP	RGE	
Permanent Datum		GROUND LEVEL		Elev. 11.0'
Log Measured from		KELLY BUSHING		31.30 Ft. Above Permanent Datum
Drilling Measured from		KELLY BUSHING		
		KB		Elevations: 42.30'
		DF		41.30'
		GL		11.0'
Date	8-8-78			
Run No.	1			
Depth—Driller	8484			
Depth—Logger	8103			
Bottom Logged Interval	8100			
Top Logged Interval	1318			
Casing—Driller	20" @ 1319'			
Casing—Logger	1318			
Bit Size	17-1/2"			
Type Fluid in Hole	LIGNOSULFO- CMC			
Density and Viscosity	9.9 44			
pH and Fluid Loss	10.5 3.2 cc			
Source of Sample	FLOWLINE			
Rm @ Meas. Temp.	1.03 @ 75 °F			
Rmf @ Meas. Temp.	0.82 @ 75 °F			
Rmc @ Meas. Temp.	1.4 @ 75 °F			
Source of Rmf and Rmc	MEAS. CALC.			
Rm @ BHT	0.43 @ 158 °F			
Time Since Circ.	6 HRS.			
Max. Rec. Temp. Deg. F.	158 °F			
Equip. No. and Location	6139 PEAR.			
Recorded By	WEST-D. GOODE			
Witnessed By	MR. J. MC GUFFIN			

Equipment Used

Series No.

Run No.

S.O.

Tool No.

Elec. No.

Drawing

Remarks: HIT A LEDGE AT 8100', LOGGED FROM 8100'

OUT AT CUSTOMER'S REQUEST. HIT ANOTHER LEDGE

AT 1500' - MANAGED TO GET FREE.

REPEAT SECTION RUN ON 4" TO 24" - CHANGED

SCALE FOR UPPER SECTION ANTICIPATING A LARGER

HOLE.

J. INAVATTARI

FORM 925260 REV.

DresserAtlas		Combination Logging Systems
		Compensated Densilog Compensated Neutron			
FILE NO.		COMPANY: GENERAL CRUDE OIL CO. - DEPT. OF ENERGY WELL: GCO-DOE PLEASANT BAYOU #1 FIELD: WILDCAT (CHOCOLATE BAYOU AREA) COUNTY: BRAZORIA STATE: TEXAS LOCATION: * SEC. _____ TWP. _____ RGE. _____			
				Other Services DIFL-A/L TEMP. SWC CALIPER	
Permanent Datum: GROUND LEVEL Elev. 11.0' Log Measured from: KELLY BUSHING 31.30 Ft. Above Permanent Datum Drilling Measured from: KELLY BUSHING		Elevations: KB 42.30 DF 41.30 GL 11.0			
Date	7-29-78				
Run No.	1				
Service Order	03476				
Depth—Driller	8478				
Depth—Logger	8478				
Bottom Logged Interval	8476				
Top Logged Interval	1315				
Casing—Driller	20 @ 1319	@	@	@	@
Casing—Logger	1315				
Bit Size	12.25				
Type Fluid in Hole	LIGNOSULF				
Density and Viscosity	10.7 38				
pH and Fluid Loss	10.5 6.0 cc	cc	cc	cc	cc
Source of Sample	FLOWLINE				
Rm @ Meas. Temp.	1.15 @ 70 °F	@ °F	@ °F	@ °F	@ °F
Rmf @ Meas. Temp.	0.86 @ 70 °F	@ °F	@ °F	@ °F	@ °F
Rmc @ Meas. Temp.	1.44 @ 70 °F	@ °F	@ °F	@ °F	@ °F
Source of Rmf and Rmc	CALC CALC				
Rm @ BHT	0.5 @ 158 °F	@ °F	@ °F	@ °F	@ °F
Time Since Circ.	17 HRS				
Max. Rec. Temp. Deg. F.	158 °F	°F	°F	°F	°F
Equip. No. and Location	6139 PEARL				
Recorded By	PERMENTER - BROWN				
Witnessed By	KELLEY				

FOLD HERE

Remarks G/R RECORDED 1.5' SHALLOW TO DENSILOG.

*UNAVAILABLE

FORM 925260 REV.

DresserAtlas		Combination Logging Systems Compensated Densilog FORMATION FACTOR
FILE NO.		COMPANY <u>GENERAL CRUDE OIL CO.</u> DEPT. OF ENERGY WELL <u>GCO-DOE PLEASANT BAYOU #1</u> FIELD <u>WILDCAT (CHOCOLATE BAYOU AREA)</u> COUNTY <u>BRAZORIA</u> STATE <u>TEXAS</u> LOCATION: * SEC _____ TWP _____ RGE _____			
		Other Services DIFL-A/L TEMP. SWC CALIPER			
Permanent Datum <u>GROUND LEVEL</u> Elev. <u>11.0'</u> Log Measured from <u>KELLY BUSHING</u> <u>31.30</u> Ft. Above Permanent Datum Drilling Measured from <u>KELLY BUSHING</u>		Elevations: KB <u>42.30'</u> DF <u>41.30'</u> GL <u>11.0'</u>			
Date	7-29-78				
Run No.	1				
Service Order	03476				
Depth—Driller	8478				
Depth—Logger	8478				
Bottom Logged Interval	8476				
Top Logged Interval	1315				
Casing—Driller	20 @ 1319	@	@	@	@
Casing—Logger	1315				
Bit Size	12.25				
Type Fluid in Hole	LIGNOSULF.				
Density and Viscosity	10.7 38				
pH and Fluid Loss	10.5 60 cc	cc	cc	cc	cc
Source of Sample	FLOWLINE				
Rm @ Meas. Temp.	1.15 @ 70 °F	@	°F	@	°F
Rmf @ Meas. Temp.	0.86 @ 70 °F	@	°F	@	°F
Rmc @ Meas. Temp.	1.44 @ 70 °F	@	°F	@	°F
Source of Rmf and Rmc	CALC. CALC.			°F	
Rm @ BHT	0.5 @ 158 °F	@	°F	@	°F
Time Since Circ.	17 HRS				
Max. Rec. Temp. Deg. F.	158 °F	°F	°F	°F	°F
Equip. No. and Location	6139 PEARL				
Recorded By	PERMETER-BROWN				
Witnessed By	KELLEY				

FOLD HERE

Remarks G/R RECORDED 1.5" SHALLOW TO DENSILOG.

* UNAVAILABLE

EXPLORATION LOGGING

1" Correlation Log

A GEOLOGICAL - ENGINEERING SERVICE

REMARKS		ABBREVIATIONS		COMPANY GENERAL CRUDE	
DRILLING CONTRACTOR WELSH DRILLING CO.	RIG NO. 15	NB NEW BIT	W MUD WEIGHT	WELL PLEASANT BAYOU No. 1	
SPUD DATE 7/1/78		RRB RERUN BIT	V MUD VISCOSITY	FIELD WILDCAT	
TYPE MUDS LIGNOSULFONATE		CB CORE BIT	F MUD FILTRATE ☐ CC/30 MIN	LOCATION SOUTH OF ALVIN TEXAS	
		CR CIRCULATE RETURNS	FC FILTER CAKE	COUNTY, STATE BRAZORIA COUNTY, TEXAS	
		NR NO RETURNS	SD SAND CONTENT	API WELL INDEX NO.	
		PR POOR RETURNS	S SALINITY ☐ G/G ☐ PPM	ELEVATION 31.30 FEET (KB)	
		LAT LOGGED AFTER TRIP	R RESISTIVITY OF MUD	DATE FROM 7/19/78 TO 1/1/77	
		TG TRIP GAS	RF RESISTIVITY MUD FILTRATE	DEPTH FROM 5300 FT TO 15075 FT	
		CG CONNECTION GAS		UNIT NO. 124	
		C CARBIDE		LOGGING GEOLOGISTS MIKE TREAT MIKE CAMPBELL	
		DST DRILL STEM TEST			
		J DST INTERVAL			
		I CORE INTERVAL			
OIL Based on live oil in unwashed cuttings and percentage staining of washed cuttings.		GAS UNITS Gas Detector calibrated to record 100 units with a mixture of 2% methane-in-air			
LITHOLOGY SYMBOLS					
☐ LIME- STONE	☐ DOLO- MITE	☐ GYPSUM AND ANHYDRITE	☐ SALT	☐ COAL AND LIGNITE	☐ CLAY
☐ SHALE	☐ SILT- STONE	☐ SANDY SILTST.	☐ SAND	☐ CONGL- OMERATE	☐ CHERT
☐ VOL- CANICS	☐ INTRU- SIVE

CLAYSTONE: MULTICOLORED
NEUTAN-BROWN-GRAY, SO
GRADING TO LT GREY, BL
SHALE

F-7

SANDSTONE: CLEAR QUAR
NEED SHALE, ROUGHED
PROSTED, FRIABLE, FLUOR
CRID, TA MINAL FLUOR
CUT OR STAIN

F-7

EXPLORATION LOGGING

Pore Pressure Evaluation
Log

A GEOLOGICAL - ENGINEERING SERVICE

REMARKS

DRILLING CONTRACTOR
WELSH DRILLING CO.
SPUD DATE **7/1/78**
TYPE MUDS
LIGNOSULFONATE

RIG NO.
15

ABBREVIATIONS

NB	NEW BIT	W	MUD WEIGHT
RRB	RERUN BIT	V	MUD VISCOSITY
CB	CORE BIT	F	MUD FILTRATE ☐ CC/30 MIN
CR	CIRCULATE RETURNS	FC	FILTER CAKE
NR	NO RETURNS	SD	SAND CONTENT
PR	POOR RETURNS	S	SALINITY ☐ G/G _____ ☐ PPM _____
LAT	LOGGED AFTER TRIP	R	RESISTIVITY OF MUD
TG	TRIP GAS	RF	RESISTIVITY MUD FILTRATE
CG	CONNECTION GAS		
C	CARBIDE		
DST	DRILL STEM TEST		
I	DST INTERVAL		
I	CORE INTERVAL		

COMPANY GENERAL CRUDE

WELL PLEASANT BAYOU No. 1

FIELD WILDCAT

LOCATION SOUTH OF ALVIN TEXAS

COUNTY, STATE BRAZORIA COUNTY, TEXAS

API WELL INDEX NO.

ELEVATION 31.30 FEET (KB)

DATE FROM 7/19/78 TO 1/3/79

DEPTH FROM 5300 FT TO 15075 FT

UNIT NO. 124

LOGGING GEOLOGISTS MIKE TREAT
MIKE CAMPBELL

CASING RECORD

13 3/8" AT 8470 FT

AT

HOLE SIZE

17 1/2" TO 8470 FT

12 1/2" TO 15675 FT

OIL Based on live oil in unwashed cuttings and percentage staining of washed cuttings.

GAS UNITS Gas Detector calibrated to record 100 units with a mixture of 2% methane-in-air.

LITHOLOGY SYMBOLS

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
LIME- STONE	DOLO- MITE	GYPSUM AND ANHYDRITE	SALT	COAL AND LIGNITE	CLAY	SHALE	SILT- STONE	SANDY SILTST.	SAND	CONGL- OMERATE	CHERT	VOL- CANICS	INTRU- SIVE

APPENDIX G

A PROSPECTUS

GEOPRESSURED GEOTHERMAL PROSPECTS AND TEST-WELL SITES
WILCOX GROUP AND FRIO FORMATION
TEXAS GULF COAST

D. G. BEBOUT, A. R. GREGORY, R. G. LOUCKS, B. R. WEISE

Assisted by

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H. S. Hamlin
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J. B. Swanson

Prepared for
The U. S. Department of Energy
Division of Geothermal Energy
December 1978

COPY No.

Bureau of Economic Geology
The University of Texas at Austin
W. L. Fisher, Director

INTRODUCTION

The four geopressured geothermal prospects and test-well sites described in this report (fig. 1 and table 1) are believed to represent the most favorable locations for testing the resource along the Texas Gulf Coast. The regional and site-specific studies used in selecting the Frio prospects have been published by the Bureau of Economic Geology (Report of Investigations 91); the supporting studies for the Wilcox prospects will be published by mid-1979. Detailed stratigraphic and structural cross sections and net-sandstone and structure maps have been prepared for the fairways in which these prospects are located. It is anticipated that other prospects will be identified in these and other fairways during the course of further study and will be reported on later. It should be emphasized that these prospects and sites have been chosen on the basis of geology alone and that equally important environmental and legal (surface and mineral rights) aspects have not been considered.

The total-resource values shown in the last two columns of Table 1 are very general estimates and are intended only to project an impression as to the magnitude of the resource in these local areas.

A significant departure has been made in the manner in which the top of geopressure is picked in this report. In previous Bureau of Economic Geology reports the top of geopressure is defined as the point at which the pressure gradient exceeds .7 psi/ft; the pressure gradient was determined primarily by plotting drilling-mud weights, a method recognized as highly tentative. For this report the top of geopressure is picked at the depth at which the plot of the shale resistivity from the electrical log departs from the normal compaction curve. This method is believed to be considerably more reliable.

Figure 1. Frio, Vicksburg, and Wilcox geothermal fairways and locations of test-well prospects.

Table 1. Summary of data from prospective test-well site. Methane solubility calculated from a table by Haas (USGS Open File Report 78-1004).

PROSPECT	Clinton	Austin Bayou	Candelaria	Eagle Lake
LOCATION OF TEST WELL	DeWitt Co. 8S-22E-8	Brazoria Co. 6S-38E-7	Kenedy Co. 25S-18E-5	Colorado Co. 4S-30E-2
DEPTH OF RESERVOIR SANDSTONE	10,950 to 13,250 ft	12,000 to 17,000 ft	10,700 to 16,000 ft	11,280 to 12,880 ft
SANDSTONE THICKNESS	10,950-12,000 ft (645 ft proposed reservoir section) 12,000-13,250 ft (700 ft deeper section)	12,000-14,000 ft (220 ft top of geopressure to 300°F) 14,000-17,000 ft (900 ft greater than 300°F)	10,500-13,400 ft (865 ft top of geopressure to 300°F) 13,400-16,000 ft (635 ft greater than 300°F)	1050 ft
MINIMUM AREA	11.4 mi ²	18 mi ²	44 mi ²	10 mi ²
PERMEABILITY	.01 to 242 md	20 to 174 md - top of geopressure to 300°F; 8 to 1041 md - greater than 300°F	30 to 60 md - top of geopressure to 300°F; .1 to 10 md greater than 300°F	0 to 545 md
AVERAGE POROSITY	16% in proposed reservoir section	18% - top of geopressure to 300°F; 16% greater than 300°F	15% - top of geopressure to 300°F; 13% - greater than 300°F	13%
TEMPERATURE	Range: 280-350°F; average upper interval: 275°F; average lower interval: 325°F	Range: 270-360°F; average upper interval: 284°F; average lower interval: 332°F	Range: 240-340°F; average upper interval: 275°F; average lower interval: 325°F	Range: 280°-325°F; ave. 300°F
TOP OF GEOPRESSURE	10,500 ft	12,000 ft	10,700 ft	12,000 ft
SALINITY ppm; NaCl	Range: 30,000 to 100,000 average 60,000	Range: 40,000 to 90,000 average 60,000	Range: 35,000 to 110,000 average 75,000	Average: 90,000
FORMATION PRESSURE (PSI)	Average upper interval: 8250; average lower interval: 10,500	Average upper interval: 9500; average lower interval: 13,250	Average upper interval: 9750; average lower interval: 13,250	Average: 8500
METHANE SOLUBILITY ft ³ /bb1 H ₂ O (USGS tables; Haas, 1978)	Upper interval: 27.02 Lower interval: 39.06	Upper interval: 31.05 Lower interval: 46.80	Upper interval: 27.60 Lower interval: 41.26	26.29
IN-PLACE RESOURCE	H ₂ O (bb1) 1.22 x 10 ¹⁰ CH ₄ (ft ³) 4.04 x 10 ¹¹	H ₂ O (bb1) 1.64 x 10 ¹⁰ CH ₄ (ft ³) 7.12 x 10 ¹¹	H ₂ O (bb1) 4.64 x 10 ¹⁰ CH ₄ (ft ³) 1.53 x 10 ¹²	H ₂ O (bb1) 6.78 x 10 ⁹ CH ₄ (ft ³) 1.78 x 10 ¹¹
RECOVERABLE RESOURCE (5% of in place)	H ₂ O (bb1) 6.1 x 10 ⁸ CH ₄ (ft ³) 2.02 x 10 ¹⁰	H ₂ O (bb1) 8.2 x 10 ⁸ CH ₄ (ft ³) 3.56 x 10 ¹⁰	H ₂ O (bb1) 2.32 x 10 ⁹ CH ₄ (ft ³) 7.65 x 10 ¹⁰	H ₂ O (bb1) 3.39 x 10 ⁸ CH ₄ (ft ³) 8.91 x 10 ⁹

CLINTON PROSPECT
DeWitt County, Texas
Wilcox Group

Location (figs. 1 and 2)

This prospect is in south-central DeWitt County and includes the Cook South and Cuero South Fields. The proposed test-well site (8S-22E-8) is 3 miles south of the town of Clinton.

Depth of Reservoir Sandstones (fig. 3)

The top of the prospective reservoir sandstones is at 10,815 (-10,530) feet on the type log. In other nearby wells the depth ranges from 10,860 to 10,990 feet. The base of the sandstone section on the type log is at 11,940 (-11,655), near the total depth of the well. In a nearby deeper well, additional sandstones occur to a total depth of 13,120 feet.

In the test well, the top of the reservoir sandstones should be at 10,950 feet.

Sandstone Thickness and Character (fig. 3)

On the type log 645 feet of sandstone occur in the proposed reservoir section. The sandstone beds range in thickness from 5 to 30 feet on the type log. The thicker beds are in the upper 300 feet of the reservoir section. Deeper sandstones were penetrated in a nearby well and cumulate to 700 feet in thickness; individual beds range from 5 to 40 feet in thickness. Similar sandstone thicknesses are expected in the test-well.

Areal Distribution and Reservoir Boundaries (fig. 2)

The prospect is approximately 1.75 miles wide (NW-SE) and 6.5 miles long (SW-NE) and 11.4 square miles in area. Major growth faults form boundaries on the updip (northwest) and downdip (southeast) side of the prospect. These faults, as shown on the map, are located with respect to the top of the Wilcox and dip to the southeast. Thus, the prospect area, shown by the hatchures, is shifted in that direction. Along strike to the southwest and northeast, faults and facies changes result in considerably less sandstone beyond the hatchured area.

Permeability, Porosity (fig. 3)

Whole-core analyses from the reservoir section in the type well show a range in porosity from 6 to 25 percent and permeability from 0.01 to 242 millidarcys. Highest permeability occurs in the top 300 feet of the prospective section, but the lower permeabilities are more common. In

the type well highest permeability (25-242 md) occurs between 10,978 and 10,985 feet. No analyses are available from the sandstones in the deeper section.

Temperature (fig. 3)

In the type well (fig. 3) a temperature of 200°F occurs at 7200 feet and 300°F at 11,400 feet. The maximum bottom-hole temperature recorded was 313°F corrected to the equilibrium value. The prospective reservoirs should have fluid temperatures ranging from 275° to 313°F. The temperature gradient is 2.6°F/100 feet at depths of interest for the DeWitt County area

Pressure

The top of geopressure on the type log is interpreted to be at 10,500 feet. Bottom-hole pressure from 10,816 to 10,876 feet was 7100 psi based on a one-hour shut-in pressure test.

Salinity

Salinity calculated from log analysis ranges between 30,000 and 100,000 ppm total dissolved solids.

Operators of Nearby Wells

Atlantic Richfield, Exxon, Lone Star, Standard of Texas, Mitchel.

Figure 2. Clinton Prospect and type-well and test-well locations. Faults are located for the top of the Wilcox Group.

SECOND TEST-WELL SITE
AUSTIN BAYOU PROSPECT
Brazoria County, Texas
Frio Formation

Location (figs. 1, 7, and 8)

This test-well site is in the Austin Bayou Prospect, Brazoria Fairway (6S-38E-7). It is two miles directly west of Department of Energy/General Crude No. 1 Pleasant Bayou geopressed geothermal well.

Depth of Reservoir Sandstones (fig. 8)

Depth to the top of the reservoir sandstones in the Austin Bayou Prospect is approximately 12,000 feet (top of geopressure). Depth to sandstones that have fluid temperatures greater than 300°F occur deeper than the Frio sandstone T5 marker (14,250 feet). Deepest prospective sandstones in the prospect are estimated to be at a depth of 17,000 feet.

Sandstone Thickness and Character (figs. 8, 9, and 10)

Approximately 220 feet of sandstone occur from the top of geopressure to the depth where 300°F is reached in the test well. As shown by the Texas Co. and Fort Bend Co. No. 2 Houston Farms and the No. 1 Pleasant Bayou well, the sandstones in this zone are in units up to 150 feet thick separated by shales up to 300 feet thick. Individual sandstone beds range in thickness from a few feet to 40 feet and are separated by shale up to 15 feet thick.

Sandstone thickness from the depth where 300°F is reached to the bottom of the prospective zone is approximately 900 feet. Sandstones in this zone are in units up to 800 feet thick, separated by shales up to 300 feet thick. Individual sandstones range in thickness from a few feet to 70 feet and are separated by shale beds up to 30 feet thick.

Total sandstone from the top of geopressure to the bottom of the prospective zone is estimated at 1120 feet.

Areal Distribution and Reservoir Boundaries (figs. 7 and 8)

The reservoir is bounded to the southwest by the Danbury salt dome and its associated faults, to the northwest by a large growth fault, to the northeast by a series of faults associated with the Chocolate Bayou area, and to the southeast by facies changes to shale. The prospect is estimated to be 18 square miles.

Permeability (fig. 10)

Whole-core analyses from the Department of Energy/General Crude No. 1 Pleasant Bayou well show that in the zone from the top of geopressure (approximately 12,000 feet) to the depth where 300°F is reached permeabilities range from 20 to as high as 174 millidarcys in the better quality sandstones. Average porosity in this zone is 18 percent. Below the depth where 300°F is reached, permeabilities are extremely poor (less than one millidarcy) in the thin sandstones but are very high (averaging 293 millidarcys with a range of 8 to 1041 millidarcys) in the thicker sandstones. Average porosity in this zone is 16 percent.

Temperature

Measured temperatures of 200°F and 300°F in the area occur at depths of 8300 feet and 13,800 feet, respectively. The highest fluid temperature expected is approximately 360°F at 17,000 feet.

Pressure

The top of geopressure is picked at about 12,000 feet.

Salinity

Salinity is expected to be in the range from 40,000 to 90,000 ppm total dissolved solids.

Operators of Nearby Wells

Major operators in the area are Exxon Company, Phillips Petroleum Company, General Crude Oil Company, and Texaco Incorporated.

Figure 7. Structure on top of the T5 marker, Brazoria Fairway.

Figure 8. Net-sandstone map, Austin Bayou Prospect, and location of test-well site, Brazoria County, Texas. Data are compiled from structure map and paleo net-sandstone maps.

Figure 9. Type log, Texas and Fort Bend #2 Houston Farms, Austin Bayou Prospect.

Figure 13.
Department of Energy and General Crude
#1 Pleasant Bayou
Brazoria County
65-39E-9

CANDELARIA PROSPECT
Kenedy County, Texas
Frio Formation

Location (figs. 1 and 15)

The prospect is in the area of the Candelaria Field (Armstrong Fairway) in west-central Kenedy County, Texas. The test-well site is two miles north of the town of Armstrong (25S-18E-5).

Depth of Reservoir Sandstones (fig. 16)

Depth to the top of reservoir sandstones in the Candelaria Prospect is 10,700 feet (top of geopressure). Deepest prospective sandstones in the prospect are estimated to be at depths of 15,000 to 16,000 feet.

Sandstone Thickness and Character (fig. 16)

Sandstone thickness from top of geopressure to a temperature of 300°F on the type log is 1050. Sandstones in this zone are in units up to 250 feet thick separated by shales up to 70 feet thick. Individual sandstone beds range in thickness from a few feet to 20 feet and are separated by thin shales commonly less than 20 feet thick.

Sandstone thickness from a temperature of 300°F to the bottom of the prospective zone is more than 450 feet. Sandstones in this zone are in units 200 to 400 feet thick, separated by shales 200 to 500 feet thick. Individual sandstone beds range in thickness from a few feet to 10 feet and are separated by thin shales.

Total sandstone from the top of geopressure to the bottom of the prospective zone is more than 1500 feet in the type well. In a structurally lower area than the type well more sandstone should occur above a temperature of 300°F than in the type well. An estimated 635 feet of sandstone should be encountered with fluid temperature above 300°F.

Areal Distribution and Reservoir Boundaries (fig. 15)

The reservoir is bounded on the northwest, northeast, and southeast by faults. To the southwest the sandstones are expected to grade into shales. Estimated areal extent of the reservoir is at least 44 square miles.

Permeability, Porosity

Swanson and others (1975) in DOE contract report E(11-1)-2687 estimate representative permeabilities in the prospect area to range from

0.26 to 0.6 millidarcys for sandstones with temperatures greater than 300°F. Whole-core analyses in Kenedy County show that in the zone from the top of geopressure to a temperature of 300°F permeabilities range from 30 to 60 millidarcys in the better-quality sandstones. Average porosity in this zone is 15 percent. Deeper than 300°F, permeabilities are generally one millidarcy or less with a few sandstones having permeability readings between one to ten millidarcys. Average porosity in this zone is 13 percent.

Temperature

Temperatures of 200°F and 300°F in the type well occur at 8100 feet, and 13,400 feet, respectively. Swanson and others (1975) have estimated the 300°F isotherm in the Candelaria Field to be at 12,800 feet. The highest fluid temperature expected is approximately 340°F.

Pressure

The top of geopressure in the type well is at 10,700 feet as indicated by a shale resistivity-versus-depth plot.

Salinity

Swanson and others (1975) report salinities in deep sandstones of Kenedy County to range from 35,000 to 110,000 ppm total dissolved solids.

Operators of Nearby Wells

Exxon Company is sole operator in the Candelaria Field area.

Figure 15. Candelaria Prospect and type-well and test-well locations.

EAGLE LAKE PROSPECT
Colorado County, Texas
Wilcox Group

Location (figs. 1 and 19)

The prospect area in eastern Colorado County (3S-30E, 4S-30E) is centered approximately two miles northeast of the town of Eagle Lake. The Mohat gas field is located to the west of the prospect, the Eagle View and Chesterville North gas fields to the east and the Starr-Lite gas field to the south. None of these fields produce from the zone of interest in the Eagle Lake prospect area.

The proposed test-well site is two miles northeast of the town of Eagle Lake (4S-30E-2).

Depth of Reservoir Sandstones (fig. 20)

The top of the reservoir sandstones in the type well (Union No. A-1 Thomas) for the prospect area is at a depth of 11,180 feet (-10,976). Within the prospect area, the top of the reservoir sandstone interval ranges in depth from 10,960 feet to 11,400 feet. Although none of the existing wells in the prospect area penetrated the entire prospective interval, wells along strike but several miles from the prospect area indicate the total thickness of the prospective sandstone section to be approximately 1600 feet. Thus, the base of the reservoir sandstones in the prospect area should be at depths ranging from about 12,600 to 13,000 feet.

In the test well, the reservoir sandstone should occupy the interval from 11,280 to 12,880 feet.

Sandstone Thickness and Character (fig. 20)

On the basis of the sandstone percentage in the prospective interval of the type well and total interval thickness projected from adjacent areas, the net sandstone in the prospective reservoir is approximately 1050 feet. The sandstone beds range in thickness from 8 to 70 feet, and the intervening shale beds are from 5 to 40 feet thick. Similar sandstone thicknesses are expected in the test well.

Areal Distribution and Reservoir Boundaries (fig. 19)

The Eagle Lake Prospect, shown by the hatched area on the map, covers approximately 10 square miles. The prospect area is elongate in a northeast direction and is bounded on the northwest and southeast by major faults. These faults are located on the map with respect to the top of the Wilcox. Both faults cut the top of the reservoir section farther to the southeast, however, so that the actual prospect area is

shifted in that direction. The area is bounded on the northeast and southwest by structural highs, where temperatures in the zone of interest are much cooler than in the prospect area.

Permeability, Porosity (fig. 20)

Whole-core analyses from the prospective interval in the type well show a range in porosity from 3.8 to 19 percent and in permeability from 0 to 545 millidarcys. Average porosity for the reservoir sandstone is 13 percent. Most of the reservoir sandstone section is characterized by low permeabilities; the very high permeabilities are found only in the core taken from 11,600 to 11,660 feet.

Temperature

Temperatures in the prospect area are generally higher than the average temperatures at equivalent depths in other parts of the Harris-Colorado geothermal fairway. In the type well temperatures of 200°F and 300°F occur at depths of 6100 feet and 11,780 feet, respectively. Fluid temperatures in the reservoir section of the type well range from 275°F calculated for the top of the reservoir interval at 11,180 feet to 302°F recorded at the total depth of 11,826 feet.

In the test well, temperatures should range from approximately 280°F at the top of the reservoir interval to 325°F at the base.

Pressure

As determined from mud weights, the highest pressure gradient in the type well is 0.634 psi/ft, which was reached at a depth of 11,300 feet. Bottom-hole pressure was calculated to be 7498 psi on the basis of that gradient. In the test well, the top of geopressure is expected to be at 12,000 feet or deeper.

Salinity

Salinity calculated from log analysis for the type well is approximately 90,000 ppm total dissolved solids.

Operators of Nearby Wells

Union, Shellworth, Davis, Ambassador, Mutex, Chicago, Victory, Alcoa and Lacy, Mosbacher.

Figure 19. Eagle Lake Prospect and type-well and test-well locations.

STATUTORY AND REGULATORY CHANGES

THE UNIVERSITY OF TEXAS AT AUSTIN
CENTER FOR ENERGY STUDIES

MEMORANDUM

November 16, 1978

Engineering-Science Building 143

TO: M. H. Dorfman

FROM: A. W. Oberbeck *AWO*

SUBJECT: Statutory and Regulatory Changes

Lewis Jones and A. W. Oberbeck of CES, and J. Brooks Peden and Mel Waxler, attorneys of the Railroad Commission (RRC) staff, met in Peden's office the afternoon of November 14, 1978, to discuss possible changes in Texas statutes and RRC rules to reduce legal impediments to geopressured-geothermal resource development.

Changes in the Geothermal Resources Act and the Water Code which had been recommended in January of this year by the ad hoc committee chaired by Fred Young (then chief legal counsel of the Oil and Gas Division of the RRC) are still on track. They are being given to Rex White, Special Counsel to the RRC, who is responsible for liaison with the Texas legislature. These are recommendations resulting from the CES legal studies on ownership and water pollution control.

In the November 14 meeting, we discussed the definition for a geopressured-geothermal well which had been published recently as a change to the statewide conservation rules of the RRC for oil, gas, and geothermal resources. For greater precision, and to avoid a possible ambiguity, the published definition will be amended to change the unit for the specified pressure gradient to psi per foot rather than psi alone as it is presently stated. Further, the adjective normal applied to this abnormal pressure gradient will be deleted. Peden and Waxler will seek this change.

When Bob Harris and Fred Young of the RRC Oil and Gas Division attended the Coffey group meeting in Houston during February, 1978, they pointed out a potential difficulty for geopressured-geothermal well production which might result from the 1977 Graford case. In that case, the Texas Supreme Court limited the authority which the RRC had been using for many years to regulate production from what they found to be common reservoirs. The question this raised for geothermal resource wells was whether the RRC had existing authority to permit multiple completions in a number of geopressured sand strata which were not necessarily connected as continuous reservoirs.

Some oil and gas operators will seek a broadening of RRC authority to determine the commonality of complex oil and gas reservoir formations as in the Graford gas fields. Our group examined and agreed with a draft rewording of several sections of the Natural Resources Code. This draft will be proposed for enactment by the next legislature. It was prepared by an Austin Law firm: Clark, Thomas, Winters and Shapiro.

Statutory and Regulatory Changes
November 16, 1978

In our discussion, we agreed that the definition of a common reservoir, and the problems this raises, were applicable only to the two chapters of the code applying to the conservation of oil and gas (Chapter 85), and the regulation of natural gas (Chapter 86). The limits on RRC authority established in these chapters are apparently not directly applicable to limit the regulatory authority established for geothermal resources in Chapter 141. It was suggested that a request for geopressured multiple completion would be granted without much question by the RRC, and that the authority to designate common reservoirs was a complication only where proration of production was involved. This was not now pertinent for geopressured-geothermal wells.

Nevertheless, the group felt that it would be desirable for the UT geopressured project to support the proposed common reservoir legislation. While it might not yet be directly applicable to our problem, the broader authority might favorably influence future commission thinking with regard to granting multiple completion permission to geothermal wells. However, we felt that no change in wording of the geothermal chapter was necessary or desirable now.

In the statewide conservation rules of the RRC, Rule 6 requires an application for multiple completion of any well (oil, gas, or geothermal). No change in that rule appears to be necessary.

The principal problem for adequate geopressured well production appears to come under Rule 10. This is a very short rule which states:

No well shall be permitted to produce oil, gas, or geothermal resources from different strata through the same string of casing.

While we may assume that exceptions will be permitted if justified, a request for exception will have to be made for what is probably the normal situation in a geopressured-geothermal well. The group felt that the simplest solution would be to remove the words geothermal resources from this rule. Peden and Waxler will initiate this change.

cc: J. Brooks Peden, RRC
Mel Waxler, RRC
Lewis Jones, CES
John Vanston, CES
Keith Westhusing, DOE, Houston

APPENDIX I

LIST OF PUBLISHED REPORTS

The following reports were published as a direct result of work done previously on contract EY-76-S-05-5243.

Boyd, W. E., Completion Techniques for Geothermal-Geopressed Wells. (162 pages). 1977. (CES).

Boyd, W. E., Testing and Sampling Procedures for Geothermal-Geopressed Wells. (152 pages). 1977. (CES).

Oberbeck, A. W., The Geopressed Geothermal Resources of Texas: A Report on Legal Ownership and Royalty Issues. (52 pages). 1977. (CES).

Rogers, K. E. and A. W. Oberbeck, The Geopressed Geothermal Resources of Texas: Regulatory Controls Over Water Pollution. (80 pages). 1977. (CES).

These reports have been sent to DOE/DGE on previous dates. For copies, please contact:

Center for Energy Studies, Geothermal Division
ENS 143
The University of Texas at Austin
Austin, Texas 78712

LIST OF PUBLISHED ARTICLES AND PAPERS

- Dorfman, M. H., "Evaluation of Natural Gas from Geopressured Zones," Gas Supply Review, American Gas Association, Vol. 7, No. 1, pp. 1-4, October 1978.
- Dorfman, M. H. and R. W. Deller, "Texas Geopressured Resource Assessment," Proceedings of the Second Geothermal Conference and Workshop, Workshop Report, Taos, New Mexico, October 1978.
- Dorfman, M. H. and W. E. Boyd, "Drilling and Completion Procedures for a Geopressured Water Producer," The Drilling Magazine, IADC, pp. 30-35, March 1978.
- Dorfman, M. H., M. M. Oskay, and M. P. Gaddis, "Self-Potential Profilling-- A New Technique for Determination of Heat Movement in a Thermal Oil Recovery Field," SPE Paper #6790 presented at the 52nd Annual Convention, Denver, Colorado, October 9-12, 1977.