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INVESTIGATION AND DEFINITION OF PARAMETERS
ASSOCIATED WITH TESTING GEOPRESSURED WATER

An Interim Report, June 1, 1975—August 31, 1976

By
O. C. Karkalits
Jimmie Hodges
Paul Jones

Work Performed Under Contract No. EY-76-S-05-4937

McNeese State University
Lake Charles, Louisiana

and

Osborn, Hodges, Roberts, Wieland Engineering
Bryan, Texas

U. S. DEPARTMENT OF ENERGY
Geothermal Energy

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"INVESTIGATION AND DEFINITION OF PARAMETERS
ASSOCIATED WITH TESTING GEOPRESSURED WATER"

AN INTERIM REPORT

(Reporting Phase I Activities from June 1, 1975 through August 31, 1976)

written by

O. C. Karkalits, McNeese State University

Jimmie Hodges, O. H. R. W. Engineering

Paul Jones, Louisiana State University

ERDA Contract No. E-(40-I)-4937

THE ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION

by

McNeese State University

Lake Charles, Louisiana 70609

and

Osborn, Hodges, Roberts, Wieland Engineering

Bryan, Texas 77801

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ABSTRACT

Prior to the initiation of this project, considerable literature had appeared in technical journals, particularly geological journals, describing the potential value of the energy contained in hot geopressed waters along the northern Gulf of Mexico coast. The geographic region of interest was identified as the area between Brownsville and Pensacola, approximately 200 miles wide and 750 miles long, and therefore containing about 150,000 square miles of surface area. The resource was estimated as lying at depths between 5,000 and 25,000 feet.

Although many descriptions of this resource had been written, not much experimental data were available regarding the actual analyses of these waters, especially the methane content.

ERDA Geothermal division sponsored the current project to find out the precise analysis of the waters in the geopressed zone in a specific South Louisiana shut in gas well. This information was desired as a prelude to additional resource development projects. If the experimental results of this project were negative, doubts would be raised that there should be serious attempts at other development projects. If the results were positive (i.e., the waters were saturated with methane suggested by hydrogeological theory of this region) then ERDA would feel encouraged to proceed with larger scale projects, especially the drilling and completion of an on-purpose geopressed geothermal well.

The project was funded for the purpose of dynamic testing two aquifers tapped by an existing gas well in the Tigre Lagoon field in Vermilion Parish. Some information about the characteristics of the reservoir fluid and the behavior of the reservoir under varying flow conditions was to be obtained. The analyses of the water would be run concurrently with the flow tests.

OUTLINE

- I. INTRODUCTION
- II. OBJECTIVES OF STUDY
- III. CRITERIA FOR A SUITABLE GEOTHERMAL TEST SITE
- IV. DETERMINATION OF LOCATION OF A SUITABLE WELL
- V. EDNA DELCAMBRE et al No. 1 WELL SITE AND WELL DESCRIPTIONS
 - A. GEOLOGICAL WORK AND GEOLOGICAL MAPS
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- VII. STATIC TEST PLANS
 - A. INTRODUCTION
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VIII. DYNAMIC PLANS

A. DISPOSAL WELL

B. DYNAMIC TESTING PROCEDURE

IX. CONCLUSIONS AND RECOMMENDATIONS

X. REFERENCES CITED

APPENDICES

I. INTRODUCTION

A. NATURAL GAS IN GEOPRESSURED GEOTHERMAL RESERVOIRS

Exploratory wells drilled for oil and gas in the northern Gulf of Mexico basin commonly reached depths of 8,000 to 12,000 feet in the middle 1930's. The deeper wells frequently encountered very high formation pressure, "heaving shale", and high temperature. Stuck tools, blowouts, and lost hole led to identification of an "impenetrable" zone in drilling contracts as a legal basis for failure to reach a specified depth. Drilling technology and tools improved a great deal following World War II, and by the mid-1950's production of natural gas and distillate from "geopressured" reservoirs had been established (Stuart, 1970, page 10).

It was noted that formation waters associated with geopressured gas reservoirs contain large amounts of dissolved methane (Clarence E. Hottman, personal communication to Paul H. Jones, 1966). Methane solubility in fresh water, described by Culberson and McKetta (1951) to a pressure of 10,000 psi and temperature of 350°F, was extended by Sultanov, Skripka, and Namiot (1972) to a pressure of 16,000 psi and temperature 680°F. The effect of increasing water salinity on methane solubility was described by O'Sullivan and Smith (1972) to a temperature of 257°F and a pressure of about 8,800 psi.

It is evident from these data that the solubility of methane in water approaches its solubility in petroleum; and that, at pressures greater than 4,000 psi, methane solubility in low-salinity water increases logarithmically

with temperature. The saturation content of natural gas in formation waters of the geopressed zone in the Gulf Basin could reach 100 SCF/Bbl at 500°F and 16,000 psi, conditions not uncommon at depths greater than 18,000 feet.

The annual production of natural gas from thousands of gas reservoirs in the geopressed zone has exceeded 5 Tcf in Louisiana alone, for the past several years. Individual wells yield up to 20 million scf/day. The gas reservoirs yield a great deal more than they should, per unit decline in pressure, and a marked change in this ratio occurs with cumulative production (Hammerlindl, 1971). Some investigators believe that this increased yield results from exsolution of gas dissolved in associated reservoir water as pressure declines with production (Jones, 1976, page 27).

Tests described in this report were made to determine the actual dissolved methane content of water in two sand-bed aquifers (reservoirs) in the upper part of the geopressed zone in south-central Louisiana. These aquifers, and the conditions of temperature, pressure, and water salinity have been described to provide a basis for interpretation of the gas saturation data obtained. Neither aquifer has ever been tapped by wells in this area.

B. BACKGROUND ON MCNEESE RESEARCH PROJECT

No formal solicitation was made by ERDA for testing existing geopressed wells. McNeese officials learned of the well test need when a conference on this subject was held on January 14, 1975 at McNeese, during which the ERDA representatives, Dr. David Lombard and Mr. Orde Evans, described the needed activities for implementing the geopressed resource development. As a result

of this meeting, President Leary of McNeese appointed Dean O. C. Karkalits of the School of Engineering and Technology to cooperate with Dean Spencer of the School of the Sciences to investigate and report to him if McNeese should make a proposal.

Contacts with numerous agencies and individuals were made between January 14 and March 13, 1975. A meeting was held at McNeese State University on March 13, 1975 with a committee of local engineers, scientists, and oil company representatives. As a result of this meeting, Deans Karkalits and Spencer recommended to President Leary that a proposal be submitted to ERDA to do static testing of a well in the Gulf Coast in a geopressured zone. Dean Karkalits was appointed by Dr. Leary to prepare such a proposal for McNeese.

Dean Karkalits solicited the assistance of Dr. Paul Jones of LSU and Messrs. Bill Osborn and Jimmie Hodges of the Osborn-Hodges Engineering Company in the preparation of a proposal.

The proposal requested that ERDA fund a project to secure the use of a shut-in oil or gas well penetrating geopressured water sands. The waters in one or more sands would be sampled by a wire-line sampler and analyzed for gas content and chemical constituents. The samples would be taken at as near in situ conditions as possible.

Only very limited data now exist in files of some oil companies concerning the amount of gas in the geopressured waters. Although there is wide agreement that the waters contain gas, there is widespread disagreement as to how

much, (i.e., the degree of saturation) and also how pure. Will the methane contain significant quantities of CO_2 , H_2S , radon, and toxic chemical species? Clearly a test of this type is a required prerequisite to ultimate evaluation and exploitation of the resources.

The proposal was completed with the help of Jones, Osborn, and Hodges, and delivered to ERDA/DGE in Washington by Dean Karkalits on April 21, 1975. The project proposal was approved as a basis for negotiating a contract on May 13. The contract was approved on June 19 and funded for 237,300 dollars, effective June 1, 1975.

The contract between McNeese and ERDA/DGE was planned for a duration of eight months, with a termination date set as February 28, 1976. Changes were made in the project objectives, requiring extensive modifications in the allocation of funds. Revised objectives were agreed upon in a meeting with a review board which met in Houston on September 26, 1976, as discussed in Section IV.

II. OBJECTIVES OF STUDY

There were four major objectives put forth in the original (Phase I) proposal of April 21, 1975. These are listed below:

A. IDENTIFY AND LOCATE A SUITABLE EXISTING WELL THAT
PENETRATED GEOPRESSURED SAND AQUIFERS.

The area of prime interest was south Louisiana since sand bodies generally are more permeable here than in, say south Texas.

B. REVIEW EXISTING DATA PERTAINING TO PHYSICAL COMPLETION
OF A GEOPRESSURED WELL.

Cooperation with oil company geologists and reservoir engineers in this work was anticipated as a necessary step in completing this objective.

C. STATIC TEST AN EXISTING WELL.

Static testing of a well can best be understood when compared with dynamic testing. The latter refers to tests during which the geopressured water is allowed to flow from its aquifer to the surface at significant rates. On the other hand, static testing refers to obtaining samples from a geothermal reservoir under conditions of zero flow. Samples are taken by wire-line samples at in situ conditions when "static" conditions are maintained.

D. PRESENT A FINAL REPORT.

A comprehensive report will be written for ERDA in which all data and interpretations thereof are presented. Conclusions and recommendations are also an integral part of the final report.

As a result of a meeting with a Review Board convened by ERDA/DGE on September 26, 1975, a revised set of objectives for dynamic testing (Phase II) was drafted. The revised objectives are:

A. PRODUCE GEOLOGIC MAPS OF RESERVOIR.

Detailed geological maps of each of the two sands penetrated by the well, and which are to be tested, will be prepared as follows:

1. Structure - contour on top and bottom of each sand.
2. Cumulative net sand thickness for each section (identified in (I)).
3. Map of top of the geopressed zone.
4. An isothermal map at 200°F (and one at 250°F if possible). Each of the above maps will encompass an area of approximately a ten-mile radius of the test well and will be somewhat askewed areally to the north.

B. SECURE AND ANALYZE RESERVOIR FLUID.

Fluid samples, from each of the two sands to be tested, will be secured under conditions of temperature and pressure approaching in situ values. Tests will be performed on the fluid samples to determine:

1. Viscosity, density, compressibility.
2. Total dissolved solids (including silica).
3. Salinity (chemical analysis of dissolved solids).
4. Dissolved gas content.
5. Spectroscopic analysis.
6. Total undissolved solids.

C. DETERMINATION OF RESERVOIR FLOW RATES.

Each of the two sands to be tested will be flowed at various rates to determine the rate at which each reservoir will produce fluid.

D. DETERMINATION OF SAND PROBLEMS.

Each of the two sands to be tested will be flowed at various rates to determine at what fluid flow rates significant sand particles from the reservoirs are produced with the fluid and the effect thereof.

E. DETERMINATION OF THE KH VALUES OF THE SANDS.

Tests will be performed, on each of the two test sands, in order to determine the minimum kh (permeability times net sand thickness) of each reservoir.

F. DETERMINATION OF HOW ADDITIONAL DYNAMIC TESTS ON GEOPRESSURED RESERVOIRS CAN BE ACCOMPLISHED.

From the testing set forth above, considerable knowledge will be obtained, thus giving direction as to how additional testing of geopressured reservoirs can be accomplished in order to obtain optimum information from the tests.

III. CRITERIA FOR A SUITABLE GEOTHERMAL TEST SITE

The following criteria were used as a guide to selecting a suitable well to act as a geothermal test site.

1. The temperature in the geopressured zone should be greater than 280°F.
2. The pressure gradient should be greater than 0.6 psi per foot of depth.
3. The summation of the individual sand bed thicknesses should exceed 1,500 feet.
4. The 1,500 feet of cumulative thickness of sand beds should be within a 3,000 foot thick envelope of combined sand and shale.
5. The permeability of the sand beds should exceed 1,000 millidarcy feet (permeability times net feet).
6. The calculated water salinities, from the electric log data, should not exceed 35,000 ppm.

IV. DETERMINATION OF LOCATION OF A SUITABLE WELL

McNeese State University, as prime contractor to ERDA for the project, subcontracted the Osborn-Hodges Engineering Company of Bryan, Texas for engineering services connected with well-site operations. Osborn-Hodges was assigned responsibility for identifying and locating a suitable well on June 1, 1975.

Most of the project team members attended the first Geopressed Geothermal Energy Conference in Austin on June 2-4, 1975. Contacts with several oil company representatives were made at this meeting, but no definite results were obtained regarding a suitable test well.

After the conference, a concentrated effort was made towards securing potential test wells for this project. Operators with whom Osborn-Hodges Engineering had personal contacts were approached first. More than 176 companies in all were contacted by mail and by phone. About 25 per cent of the companies responded to the letters and only two possible test wells were offered.

The major concern of the companies contacted was the liability that they would be exposed to by allowing work to be done on a well. To counter this, and to encourage cooperation by the oil companies, an insurance package was prepared by Lloyds of London through a local broker, whereby guarantees of protection against all potential claims would be given.

The first well which was offered by Tesoro was a Wilcox test near Ville Platte, Louisiana. The well was being drilled, but the drilling operations encountered problems in maintaining the mud weight because of high temperatures and pressures.

A piece of pipe had been dropped in the hole and recovery seemed unlikely preventing the resumption of regular drilling activities. A review of the well log indicated that the Wilcox formation could not be expected to yield the desired quantities of water. Considering these problems, it was decided that this well was not suited to this project.

In July, 1975, Coastal States Gas Producing Company notified Osborn-Hodges-Roberts-Wieland Engineering that they would allow geopressure testing of the Edna Delcambre No. 1 in Vermilion Parish, Louisiana. A full examination of the well was made by Osborn-Hodges-Roberts-Wieland Engineering with the assistance of Mr. Jack Logan of Coastal States. The Edna Delcambre No. 1 had the necessary requirements for a test well.

The bottom hole temperature of 260°F, as recorded on the log of this well, was less than desired (see section III). It should be remembered, however, that the recorded temperature is an uncorrected temperature. The "true" (or corrected) temperature could be 20°F higher than recorded, bringing it to approximately 280°F, which is the minimum desired for a suitable test well.

A major draw back was that the well is located in an inland water area and is only accessible by boat or plane. Because of the location, the cost of the testing program increased significantly.

After examining the log of the well, Messrs. Osborn and Hodges concluded that the well penetrated some good water sands in the geopressured zone. As mentioned above the well is not quite warm enough, (260°F versus, 280°F), but other good features outweigh this disadvantage.

Figure 1
GEOGRAPHIC LOCATION
OF WELL

Scale of Miles
0 20 40 60 80

(12)

FIGURE 2
BARGE SLIP SERVING THE WELL

OHRW ENGINEERING	
EDNA DELCAMBRE #1 Geothermal - Geopressure Test	
EXISTING SITE	
Date: 4 FEB 78	SHEET 1 OF 6
Drawn by: DFC CLB	
Approved by:	
C & S Drafting Co.	

A meeting was held in Bryan, Texas, August 21 and 22 to discuss detailed testing plans. Present at the meeting were: Osborn, Hodges, Jones, Evans, and Jack Logan of Coastal States. The consensus was: (1) the sands are part of the Planulina basin, (2) the basin has an areal extent of approximately 75 or 80 square miles, (3) conditions are favorable for a dynamic test as well as a static test, (4) McNeese should propose to ERDA that the project be expanded to include dynamic testing as well as static testing.

A new proposal was submitted to ERDA, Division of Geothermal Energy, on September 10, 1975. The proposal was carried in person by O. C. Karkalits and presented to Dr. David Lombard. After review, some minor changes were made. It was recommended that the revised proposal be presented orally to a review board. The meeting of project team members and the review board was to be held late in September in Houston. McNeese State University revised the proposal in mid-September for the special review board meeting.

The review board met in the Houston headquarters of Shell Oil Company on September 26, 1975. Present were: David Lombard, Orde Evans, Charles Matthews, Jim Hartman, Henry Dunlap, Myron Dorfman, Tony Podio, Jim Roberts, Bob Matthews, Sidney Kaufman, Jack Logan, O. C. Karkalits, Bill Osborn, Jimmie Hodges, and Paul Jones. The main features of the proposal were presented by the project team and logs of the Delcambre well were presented along with details of the testing program. The project team proposed to test three sands, but the consensus of the board was this should be reduced to two sands, the No. 1 at 12,600 feet and the No. 3 at 12,900 feet depths.

Subsequent to the board meeting, McNeese State University was advised to make a third revision to the dynamic testing proposal and present it to ERDA/DGE as quickly as possible. The revised proposal listed the new objectives as discussed in Section II, pages 6 and 7.

V. EDNA DELCAMBRE ET AL NO. 1 WELL SITE AND WELL DESCRIPTIONS

A. GEOLOGICAL WORK AND GEOLOGICAL MAPS

1. Introduction

The Planulina basin in eastern Vermilion Parish, Louisiana, is a lower Miocene depositional basin bounded by contemporaneous faults and named for the foraminiferal marker fossil that characterizes the deposits, (Meyerhoff and others, 1968). It was a rapidly-subsiding basin during deposition of the sand-bed aquifers and clay-bed aquitards that form the reservoirs selected for this study. Deposition kept pace with subsidence, and a series of sheet-sand aquifers ranging in thickness from a few tens of feet to 500 feet or more, now underlie an area of some 300 square miles. The upper part of this depositional sequence, which immediately underlies the top of the geopressed zone in this area, includes six to eight sand-bed aquifers, most of which have an areal extent greater than 50 square miles. (See Figure 3).

The area of investigation includes several producing oil and gas fields. Producing wells located in the general vicinity of the Coastal States, Edna Delcambre et al No. 1, selected for use in project tests, now tap or have produced fluids from all but two of the upper eight aquifers. To obtain samples of water having a dissolved gas content representative of natural, undisturbed conditions, it was decided to tap only these two aquifers in project tests. These are designated the No. 1 Sand-Bed Aquifer, and the No. 3 Sand-Bed Aquifer, in the maps and sections prepared in connection with this study.

Parameters of interest in investigation and assessment of natural gas resources

LEGEND

—12,000— LINE OF EQUAL DEPTH IN FT. DATUM, MEAN SEA LEVEL

--- FAULT LINE

— BOUNDARY OF STUDY AREA

Depth In Feet
DEPTH OF OCCURRENCE OF GEOPRESSURED ZONE
PLANULINA BASIN, EASTERN VERMILION PARISH, LOUISIANA

FIGURE 3

dissolved in formation waters of the geopressed zone include depth, thickness, and areal extent of aquifers; geologic structure, including the altitude of the top of the aquifers and the location and displacement of faults; temperature and pressure conditions in the aquifers; and the salinity of aquifer waters. Information on these parameters is necessary for calculation of the dissolved methane content of aquifer waters at saturation (Culberson and McKetta, 1951; Sultanov, Skripka, and Namiot, 1972) in the mapped area; together with porosity data for aquifers (measured or estimated), these data enable estimation of the total methane content, at saturation, of the mapped aquifers.

At this time nine maps of the Planulina basin study area have been completed. These maps, the methods used in their preparation, and the data base, are described in the following sections.

2. Depth of Occurrence of the Geopressed Zone

The depth to the top of the geopressed zone was determined using resistivity data recorded on the electric logs of oil-test and production wells in the study area. Readings were taken from the amplified short normal resistivity curve (Figures 4-a, 4-b, and 4-c) and analysed using the method of Hottman and Johnson (1965, page 717-722). Depth determinations, and the depth-pressure gradients measured were compared with mud density (Dens.) data on the electric log heading (Figure 4-a); for the Edna Delcambre et al No. 1, mud density was increased from 11.1 pounds per gallon (ppg) at a log depth of 12,317 feet to 18.2 ppg at log depth of 14,165 feet. The electric log resistivity data (Figure 4-c) show that the top of the geopressures zone -- the depth below which the fluid pressure increases markedly above hydrostatic (pressure gradient exceeds 0.465 pounds per square inch per foot

FIGURE 4a

COUNTY VERMILION FIELD or TIGRE LAGOON LOCATION WELL EDNA DELCAMBRE ET AL NO. 1 COMPANY COASTAL STATES GAS PROD. CO. PRODUCTION OIL CO.		SCHLUMBERGER INDUCTION-ELECTRICAL LOG		
COMPANY COASTAL STATES GAS PRODUCING COMPANY & PRESTON OIL COMPANY				
WELL EDNA DELCAMBRE ET AL NO. 1				
FIELD TIGRE LAGOON				
COUNTY VERMILION STATE LOUISIANA				
LOCATION Sec. 5 Twp. 14S Rge. 5E		Other Services: SLC, 0-FT, CDD-H, ST		
Permanent Datum: BHF, Elev. 2.3'		Elev.: K.B. 32.9		
Log Measured From KB 30.6 Ft. Above Perm. Datum		D.F. 31.9		
Drilling Measured From SAME		G.I.		
Date	11-27-67	11-28-67	12-19-67	1-1-68
Run No.	ONE	TWO	THREE	FOUR
Depth—Driller	12204	12310	14160	14500
Depth—Logger	12209	12317	14165	14516
Btm. Log Interval	12208	12316	14164	14511
Top Log Interval	2478	12208	12308	14083
Casing—Driller	2477	2477	12305	14069
Casing—Logger	2478	2478	12308	14083
Bit Size	9 7/8"	9 7/8"	6 5/8"	4 1/2"
Type Fluid in Hole	LIGNO	LIGNO	CLCLS	CLCLS
	SULFONATE	SULFONATE		
Dens. Visc.	11.1 40	11.1 42	18.2 51	18.2 55
pH Fluid Loss	9.5 6.2ml	9.5 6.0ml	10.0 4.0ml	10.0 3.0ml
Source of Sample	PIT	PIT	PIT	PIT
R _m @ Meas. Temp.	0.74 @ 92°F	0.80 @ 80°F	0.98 @ 82°F	0.97 @ 70°F
R _{mt} @ Meas. Temp.	0.62 @ 80°F	0.60 @ 80°F	0.74 @ 82°F	0.37 @ 60°F
R _{mc} @ Meas. Temp.	1.24 @ 80°F	1.30 @ 80°F	1.47 @ 82°F	1.11 @ 70°F
Source: R _{mt} R _{mc}	M C	M M	C C	M C
R _m @ BHT	0.37 @ 186°F	0.34 @ 188°F	0.33 @ 240°F	0.27 @ 247°F
Time Since Circ.	5 HRS.	5 HRS.	24 HRS.	1 HRS.
Max. Rec. Temp.	186 °F	188 °F	240 °F	247 °F
Equip. Location	3710 NI	3710 NI	3712 NI	3709 NI
Recorded By	BABIN	LOPEZ	BADON-DUPREE	YE VERTON
Witnessed By	FURGERSON-REED-HALL	FURGERSON-REED-HALL	FURGERSON-REED-HALL	FURGERSON-REED-HALL

The well name, location and borehole reference data were furnished by the customer.

FIGURE 4b

(19)

(17)

FIGURE 4c

of depth) -- occurs at a log depth of about 12,323 feet. As the log depth measurements were made from the kelly bushing (KB) of the drilling rig, 30.6 feet above the braiden-head flange, which was 2.3 feet above sea level datum, the total elevation correction is 32.9 feet. The depth of the top of the geopressed zone, corrected to sea level datum, is thus 12,290 feet. The map, Figure 3, was made using depth calculations of this type for all wells shown on it.

The top of the geopressed zone ranges in depth from about 11,900 feet in the North Erath Field (T 13S, R 4E) to about 13,900 feet in the Boston Bayou Field (T 14S, R 4E). In the Tigre Lagoon Field it is at a depth of 12,100 feet to 12,300 feet; and it lies below a depth of 13,000 feet in a belt about 2 miles wide extending eastward from Live Oak Field (T 4S, R 3E).

3. Depth of Occurrence of Isothermal Surfaces

Bottom-hole temperature (BHT) data recorded on electric-log headings for each logging run were corrected to equilibrium temperature at indicated depth in each well using the correction curves developed by the American Association Of Petroleum Geologists for southern Louisiana, in its Geothermal Survey of North America (Kehle, Ralph, 1972). Geothermal gradients for each well were calculated for incremental depths, from land surface to the depth reached in the first logging run, and between depths reached in successive runs, using a land surface temperature of 70°F and corrected BHT data for each run. These gradients were used to calculate the rate of temperature increase with depth between depths reached for each run, as feet per degree. The depth at which temperatures of

200°F and 250°F occurred in each well were determined from these data by interpolation between the closest depth-control points.

The depth at which an equilibrium temperature of 200°F occurs was indicated for each well on a map of the Planulina basin showing well locations, and the data were contoured. The resulting map, Figure 5, shows the depth of the 200°F isotherm in the basin.

The 200°F isothermal surface ranges in depth from about 9,500 feet to about 12,400 feet below sea level in the basin, being least in an area about 2 mi north of Bancker Field (T 13S, R 3E), and greatest in two widely separated areas, (1) the Tigre Lagoon Field (T 13S, R 4E) and (2) about 2 mi east of Live Oak Field (T 14S, R 4E). It is at a depth less than 10,000 feet within 0.2 mi NE from the Edna Delcambre No. 1 well (the project test well), but occurs at 10,640 feet in the well itself. Throughout the Planulina basin study area it generally is at depths between 10,500 and 11,000 feet.

The depth at which an equilibrium temperature of 250°F occurs was indicated for each well on another base map of the basin, and contoured. This 250°F isothermal map, Figure 6, has a configuration that is quite similar to that of the 200°F map in some areas, but markedly different in others. The 250°F isotherm ranges in depth from less than 12,500 feet to about 15,200 feet in the basin study area. It is shallowest in two localities, (1) in the west Erath Field area (T 13S, R 3, and 4E) and (2) in the Live Oak Field area (T 14S, R 3E), and deepest in the southern part of the Erath Field (T 13S, R 4E). Throughout the central part of the Planulina basin study area, the 250°F isothermal surface is below a depth of

LEGEND

—12,000—LINE OF EQUAL DEPTH IN FT.
DATUM, MEAN SEA LEVEL

FAULT LINE

_____ BOUNDARY OF STUDY AREA

FIGURE 6

14,000 feet. In the Edna Delcambre No.1 well it is at a depth of 13,170 feet.

4. Depth of Occurrence of the No.1 Sand-Bed Aquifer

The No.1 Sand-Bed Aquifer was identified on the electric logs of some fifty wells in the study area, using electric-log cross sections and structure maps for control. It appears on the electric-log segment, Figure 4-c, between depths of 12,575 feet and 12,660 feet. The top and bottom of the sand are easily identified on the Spontaneous Potential curve.

In the Planulina basin, the depth to the top of the No.1 Sand-Bed Aquifer (Figure 7) is least (12,040 feet) in the northeastern part of the study area (T 13S, R 4E). It is greatest (13,692 feet) in the Boston Bayou Field (T 14S - R 4E) in the extreme southeastern part. The top of the No. 1 Sand-Bed Aquifer is between depths of 13,000 feet and 13,500 feet in about half of the study area, and above a depth of 13,000 feet in about a third of the area.

5. Thickness of the No.1 Sand-Bed Aquifer

The depths of the top and bottom of the No. 1 Sand-Bed Aquifer were identified and recorded for the fifty wells mentioned above, and its thickness determined for each well. Thickness data are contoured in Figure 8 for all wells shown on the map.

The net thickness ranges from a minimum of 30 feet in an elongate belt immediately north of the Intracoastal Waterway, in the south-central part of the study area (T 14S, R 4E), to a maximum of 205 feet only 3 miles to the northwest (T 13S, R 4E). The thickness exceeds 100 feet in most of the study area and is about 90 feet in the project test well.

LEGEND

100 LINE OF EQUAL THICKNESS
IN FEET

FAULT LINE

BOUNDARY OF STUDY AREA

(27)

6. Salinity of Water in Sand-Bed Aquifers

The salinity of water in sand-bed aquifers was calculated from electric log data using the Schlumberger equation (Anonymous, 1972, p. 8; p. 77-80). The logged spontaneous potential (SP) of the sand bed, in millivolts, is measured by the deflection of the SP curve from its trend in overlying and underlying clay (shale) beds (the shale-base line). The electrical resistivity of the drilling mud filtrate (R_{mf}) is measured by the well-logging operator, using a sample of mud collected from the mud-return pit at the well site; the R_{mf} measurement for each logging run, and the temperature of the mud filtrate at the time of measurement, are recorded on the well log heading (fig. 4-a). The in situ temperature of the sand-bed aquifer of interest is calculated from the geothermal gradient, as described above. The spontaneous potential recorded on the electric log for clean sand-bed aquifers bounded above and below by clay beds is an electrochemical potential, and its value is related to the above parameters as follows:

$$SP = -K \log R_{mf}/R_w$$

in which SP is the observed spontaneous potential

K is a temperature function, requiring an estimate of

in situ sand-bed temperature

R_{mf} is mud filtrate resistivity in ohm meters

R_w is the resistivity of formation water in the sand-bed aquifer of interest, at in situ temperature.

If sand-bed aquifers include interbedded thin layers of clay, or dispersed clay particles, the SP curve deflection from the shale base line is reduced (its value in millivolts is too low); calculated formation water salinity is too low for highly saline formation waters, and too high for formation waters less saline than the

drilling mud filtrate. The relative amount of dispersed or interbedded clay in a sand-bed aquifer is commonly indicated by the raggedness of the spontaneous potential and resistivity curves through its depth interval.

Computer programs for making formation water salinity calculations based upon electric log data, using the Schlumberger formula, are readily available, and all salinities described for aquifers No. 1 and No. 3 in this report were computer derived. Values for R_w at in situ temperature were interpreted for aquifers of interest in terms of the dissolved solids of a sodium chloride salt solution having the calculated resistivity at that temperature. This procedure was based upon the knowledge that (1) sodium chloride (NaCl) generally comprises more than 98 percent of the dissolved solids in sand-bed aquifer waters in Neogene deposits of southern Louisiana (which include aquifers No. 1 and No. 3 in the project well), and that (2) the concentration of the monovalent cation Na^+ in these aquifer waters is the dominant factor in the generation of spontaneous potential in boreholes penetrating salaquifer systems in these deposits.

The salinity of water in aquifers No. 1 and No. 3 where penetrated by some 50 wells in the study area was calculated from the electric logs, and the results were used to construct the isosalinity maps, figures 9 and 12.

7. Salinity of Water in Sand-Bed Aquifer No. 1

The map (fig. 9) shows a belt of low-salinity water lying immediately north of the Intracoastal Waterway. The dissolved solids is less than 30,000 mg/l (as NaCl) in the area centered about 2 miles northwest of the Boston Bayou Field (T 14 W, R 4 E). It is less than 40,000 mg/l in an area about one mile south of the Bayou Hebert Field in the western part of T 14 S, R 5 E, but increases northward to more than 100,000 mg/l in the vicinity of the project test well, Edna Delcambre No. 1, in the same township.

High-salinity water, with a dissolved-solids content greater than 120,000 mg/l, is also present in the extreme southwestern part of the study area (T 14 S, R 3 E) in the vicinity of the Live Oak Field. Locally, water salinity ranges above 90,000 mg/l near Banker Field (T 13 S, R 3 E) and a mile or so west of Bayou Hebert Field (T 14 S, R 4 E).

Initial calculations of the salinity of water in aquifers No. 1 and No. 3 penetrated by the project well, based upon electric-log data, inadvertently were made using spurious Rmf figures, which gave dissolved-solids contents far lower than those determined by analysis of produced waters. These initial calculations used an Rmf value of 0.74 ohm meters at 82°F, based upon a mud sample collected from the pit during logging run No. 3, which was made some 24 hours after circulation had stopped. The calculated dissolved solids of water in the No. 1 Sand-Bed Aquifer, based on this Rmf, was about 60,000 mg/l. Analyses of water produced from the aquifer during the period June 23 to July 13, 1977, made in the laboratories of McNeese State University, show the dissolved-solids content to be about 134,000 mg/l, with NaCl accounting for 98.88 percent of the total. Evidently chemical changes in the drilling mud during the 24-hour lag time increased the mud filtrate resistivity a great deal. Calculations based upon Rmf data obtained from electric logging run No. 4, made 6 hours after circulation was stopped, yield a dissolved-solids value of about 100,000 mg/l. As the hole had been deepened only 340 ft. between runs No. 3 and No. 4, and no chemicals were added to the mud during this drilling interval, the Rmf data for run No. 4 probably should have been used in the initial calculation. The isosalinity map for Sand-Bed Aquifer No. 3 reflects this correction.

8. Depth of Occurrence of the No. 3 Sand-Bed Aquifer

The No. 3 Sand-Bed Aquifer was identified on the electric logs of some 50

(31)

(32)

wells in the project study area, and the depth to its top calculated and plotted on the well-location map. Figure 10, a contour map showing the depth to the top of the aquifer, describes a surface which is almost bowl-shaped, but open to the southeast. Depths range from a minimum of 12,450 ft. at the extreme northwest, near the North Erath Field (T 13 S, R 4 E) to a maximum of 14,273 ft. in the Boston Bayou Field area (T 14 S, R 4 E). In the project test well it is at a depth of 12,840 ft.

9. Thickness of the No. 3 Sand-Bed Aquifer

The depths of top and bottom of the No. 3 Sand-Bed Aquifer were identified and recorded for 50 wells in the study area and the thickness calculated. Thickness at each well location was recorded on the map and contoured, as shown in Figure 11. The net thickness ranges from less than 20 ft. in the extreme southeast, at the head of Vermilion Bay (T 14 S, R 5 E), to more than 240 ft. in the extreme northeastern part of the study area (T 13 S, R 5 E). Between Bancker Field and Live Oak Field, in the extreme southwestern part of the study area (T 14 S, R 3 E) the net thickness increases rapidly westward to 200 ft. or more. Thickness exceeds 60 ft. in an area of about 15 mi² in the center of the Planulina basin, and ranges from 40 to 80 ft. in the Tigre Lagoon Field area.

10. Salinity of Water in the No. 3 Sand-Bed Aquifer

Marked similarities in the water salinity distribution in Aquifers No. 1 and No. 3 are evident on the maps, figures 9 and 12. Low salinity occurs in the southern part of the study area in both aquifers, the dissolved solids ranging below 20,000 mg/l in the No. 3 Sand-Bed Aquifer in two localities. Salinity in the No. 3 Aquifer is also low near Erath Field, in the northwestern part of the study area (T 13 S, R 4 E). Both aquifers contain water with dissolved solids ranging above 80,000 mg/l in the east-central part of the study area.

(34)

Water salinity maps suggest that drainage of the aquifers has been northward and eastward, in general, in the directions of major growth faults in the Planulina Basin.

II. Geologic Structure of the Planulina Basin

The geologic structure of the Planulina Basin is that of a regionally extensive depocenter bounded by growth faults and cut by many branch faults. All faults die out both downwards and upwards from the geometric center of the depositional mass that forms the basin. An extensive marine shale, mapped as figure 13, occurs immediately above the geopressed zone in parts of Townships 13 and 14 South, Ranges 4 and 5 East. The arcuate structural high that marks the Tigre Lagoon Field has a relief of 500 to 700 ft. on this faunal marker, which is cut by growth faults on both the northeast and southwest having displacements generally less than 300 ft. Immediately to the east at a distance of about 4 miles is the Avery Island Field formed by a piercement salt dome.

On the type log shown in Figure 13 (the electric log of the Union Oil Company of California, E. Dugas Well No. 7) several marker beds are shown, along with the top of the geopressure zone, Aquifer No. 1, and Aquifer No. 3. Figure 14 is a structure map of the marker bed, Planulina No. 6 sand, showing the extremely complex fault pattern developed by master growth fault "A" - "A" and the several branch faults "B", "C", "D", and "F". The project test well, Edna Delcambre No. 1 (Coastal States et al) in section 5 T 14 S, R 5 E, is located very close to the master growth fault, on the downthrown side at the marker bed which underlies both Aquifer No. 1 and Aquifer No. 3 by 700 to 1,000 ft. The displacement of the branch fault about one mile to the north of the project well is about 150 ft., enough to cut off both aquifers; and the branch fault to the southwest at a distance of about 2,000 ft. has a displacement

(36)

FIGURE 12

STRUCTURE MAP

Planulina Sands 1 and 3

Fig. 13

of about 100 ft., and is probably also a hydraulic boundary for both aquifers. Both growth faults are shown to die out westward a few miles from the project well.

The electric log cross section, figure 15, shows the correlation of marker beds along a line trending northward from Coastal States, Edna Delcambre Well No. 2 about 3 miles to Merald Oil Company, Landry-Meaux Well No. 1.

On this section the locations of Sand Bed Aquifers No 1 and No. 3 are shown, as they appear on the log of Union Oil Company of California, E. Dugas Well No. 7. The offset of beds at the master growth fault is at least 200 feet along this line of section.

Figure 16 is a structure map of the Planulina No. 3 sand, which is Sand-Bed Aquifer No. 1 of the study. On this map the project test well is shown to be at least half a mile west from the master growth fault, which has a displacement of about 300 ft. Figure 17 is a structure map on the top of the Planulina No. 6 sand; fault patterns are markedly different from those shown in figure 14, which was prepared by a different operator.

A regional structure map, figure 18, describes the principle features of the study area.

12. Conclusion, and Continuing Studies

Investigations completed lay the basis for computation of the amount of methane in solution, at saturation, in the two aquifers of interest in the study area. A computer program for accomplishment of this objective is now being developed, with oil company assistance. In addition, conditions in the Planulina Basin related to land subsidence and waste-water disposal are in preliminary review, and it is believed that suggestions for meaningful studies of these aspects of resource development in the basin can be made at the time this project is completed.

Fig. 16

(43)

Planulina Regional Structure Map

PLANULINA BASIN, EASTERN VERMILION PARISH, LOUISIANA

FIGURE 18

B. DESCRIPTION OF EDNA DELCAMBRE NO. 1 WELL

The Edna Delcambre No. 1 is located in Vermilion Parish just north of Vermilion Bay. (See map, figure 1, page 11). The well is approximately one mile north of the Intracoastal Canal and about 1/4 mile west of the Iberia-Vermilion Parish boundary, about 75 miles southeast by east from Lake Charles, Louisiana, and about 25 miles south of Lafayette, Louisiana. The well is located in the west half of the southeast quarter of Section 5, Township 14 South, Range 5 East in the Tigre Lagoon field.

Because the well is situated in the coastal marsh, all field operations must be conducted from barges. The well was completed in 1968 and produced gas from 1968 until 1975. Total depth of the well is 14,083 feet and the top of the geopressured zone was determined to be at 12,290 feet (see page 21) with a thin transition zone -- generally less than 300 feet -- between normally pressured and overpressured sections.

The well is constructed with 10 3/4" casing to 2,477 feet. A 5 1/2", 23#, P110-X-Liner is set in 7 5/8" casing from 12,088 feet to 14,083 feet. A production string of 2 7/8" tubing extends from the well head to 13,306 feet, tailed with 2 3/8" tubing down to 13,370 feet. A Baker 43-F-30 permanent packer is set at 13,311 feet. The last gas produced came from penetration at 13,380-13,388 feet.

A fifteen foot cement plug is set at 13,459-74 feet on top of ST plug and a T-2 nipple is set at 13,474-80 feet with a Baker 43-F-30 permanent packer set at 13,480 feet.

Open perforations are located at 13,512-17 feet. A Baker 43-F-30 permanent packer is set at 13,525 feet. Open perforations are at 13,533-40 feet. A sixteen foot cement plug is set at 13,685-74 feet on top of a PN plug at 13,674-80. A Baker permanent packer, No. 42-26D, is set at 13,680 feet.

VI. LEASE TERMS AND LICENSE REQUIREMENTS

A. OWNERSHIP METHOD

A legal problem arose during October, 1975 as a result of discussions between McNeese University, ERDA Oak Ridge, and Osborn-Hodges Engineering (which became Osborn-Hodges-Roberts Engineering at about this stage in the project). In simple terms, the problem concerned the ownership of the well bore, the hardware therein, and some surface tanks and associated piping. Coastal States Gas Producing Company and partners associated with Coastal owned these tangible assets. Osborn-Hodges-Roberts Engineering did not want the responsibility of owning these assets because of the potential liability in case of a blowout during operations at the well site. The legal staff of ERDA Oak Ridge declared that neither the U.S. Government nor ERDA could (or should) own the assets. An identical statement came from the administration of McNeese State University, and echoed by the Attorney General on behalf of the State of Louisiana. Conference calls involving representatives of ERDA Oak Ridge, McNeese, and the engineering firm agreed to the establishment of Geothermic Resources, Inc. This corporation was duly organized and the officers of the corporation were principals in Osborn-Hodges-Roberts Engineering. It was agreed that Geothermic Resources would own the bore hole and associated assets, and the leases would be held by the corporation. Money for the purchase of these assets would flow from ERDA to McNeese to Geothermic Resources to implement this agreement. These legal arrangements were accomplished between October 15, 1975 and February 25, 1976.

VI (continued)

Another decision had to be made regarding the ultimate disposition of these assets during the life of the project. Some of the existing tanks and associated piping at the time the leases were executed could not be used in the geothermal research work. The existing production string in the well was to be replaced by larger diameter tubing of better quality. The original plan specified that money obtained from selling these salvagable hardware items would be sent to McNeese State University and disposed of as ERDA directed. After the establishment of Geothermic Resources, it was decided that the new corporation would sell all salvagable equipment by taking sealed bids and selling to the highest bidder. Once the assets were sold, the money realized from this sale would flow through Geothermic Resources directly to ERDA. Geothermic Resources, Inc. became a duly authorized corporation in the fall of 1975.

It should be noted that on January 1, 1976, Dr. Denton Wieland became a partner in the engineering firm originally known as "Osborn-Hodges". The firm name, therefore, became "Osborn-Hodges-Roberts-Wieland Engineering", hereinafter referred to as "OHRW Engineering".

B. LEASE ARRANGEMENTS

I. OIL, GAS AND MINERAL LEASE BETWEEN ROLAND KIDD AND THE DELCAMBRES.

Coastal States Gas Producing Co. lost their lease, which reverted back to Edna Delcambre et al. Members of the Delcambre family were then in a position to sign a lease with Roland Kidd, which they did shortly

after the Coastal States lease expired. A lease agreement, effective October 23, 1975, was signed by Edna V. Delcambre et al and Roland Kidd, Jr. The Delcambre interest leased to Kidd the 160 acres of land encompassing the Edna Delcambre et al No. 1 Well for a period of 3 years subject to certain limitations, at a lease figure of \$35.00 per acre (\$5600 for 160 acres). The lease conveys oil, gas and mineral rights to Roland Kidd, Jr, and is a "standard" lease of the type normally used in such leasing transactions.

2. LETTER OF AGREEMENT BETWEEN ROLAND KIDD, JR.
AND GEOTHERMIC RESOURCES, INC., AND OHRW ENGINEERING.

On November 11, 1975, Roland Kidd, Jr. signed a letter of agreement dealing with the rights under the mineral lease (paragraph 1) with Geothermic Resources, Inc. and OHRW Engineering. Geothermic Resources, Inc. had been established to own the hardware in the well, lease assignment and such other related equipment as surface tanks and transfer lines. It was agreed that OHRW Engineering and Geothermic Resources, Inc. would not complete a well in any sand or formation for oil, gas, or hydrocarbon production between the surface of the land and 13,300 feet. The agreement also provides that all operations shall be in accordance with terms of the agreement described in paragraph 3 between OHRW Engineering and the Delcambre interests.

3. LETTER AGREEMENT BETWEEN THE DELCAMBRES'
AND OHRW ENGINEERING.

On October 30, 1975, a letter of agreement was signed by the Delcambre interests and OHRW Engineering. The agreement gives OHRW Engineering the right of ingress and egress to and from the land at all

VI (continued)

times, as well as the right to conduct research operations in connection with geothermal waters from the Delcambre No. 1 Well. It was agreed that buildings and structures in connection with the project could be built as needed to conduct the research. The Delcambres recognize that OHRW Engineering would own the hardware connected with the Delcambre No. 1 after duly purchasing same from the owner in the name of Geothermic Resources, Inc.

4. CONVEYANCE OF INTEREST IN OIL, GAS, AND MINERAL LEASE FROM ROLAND KIDD, JR. TO GEOTHERMIC RESOURCES, INC.

On November 11, 1975, Roland Kidd, Jr. signed the conveyance of interest document conveying certain rights to Geothermic Resources, Inc. All rights and interest received by Kidd in his lease from the Delcambres (described in paragraph 1) were assigned to Geothermic Resources, Inc. Some reservations and limitations were agreed to, as follows:

- (1) Kidd conveyed the interests between the surface of the ground and 13,300 feet only.
- (2) Kidd retains right to salvage value of other wells in the 160 acre tract except Delcambre No. 1 Well.
- (3) Geothermic Resources has rights to only hydrocarbons produced in connection (or association) with geothermal waters.

VI (continued)

- (4) Kidd transfers all rights to salvagable hardware in Delcambre No. 1 Well to Geothermic Resources Inc.
- (5) Geothermal Resources will hold Kidd harmless against any claims arising from its operations. Kidd to hold Geothermic Resources harmless against claims arising from his operations on the land.
- (6) Kidd agrees to notify Geothermic Resources not less than 45 days prior to date upon which delay rentals are payable. (Delay rentals - A yearly rent paid to maintain the force of the lease because no income from the production of hydrocarbons has been generated.)
- (7) Geothermic Resources will pay the delay rental payment, in the amount and as specified in the lease, if it does not terminate its operations within 30 days of such notice (item 6).
- (8) Rights given by Kidd to Geothermic Resources, Inc. shall terminate on October 23, 1977 unless sooner terminated by Geothermic Resources, Inc.

The above agreement was signed by Roland Kidd, Jr. and by J. H. Roberts for Geothermic Resources on November 11, 1975.

C. LEASE PAYMENTS

1. ROLAND KIDD AND MORGAN CITY ASSOCIATES

The Morgan City Associates received \$8750.00 as payment for their lease and their legal fees. They also received, as noted in Section A, all rights to oil and gas below 13,300 feet.

2. THE DELCAMBRE INTERESTS.

The Delcambre family (all heirs and widow of Isidore Delcambre) received \$5,904.85 as a lease bonus.

Total money for the lease documents and letter agreements in Section A was therefore \$14,654.85, not including legal fees.

3. ATTORNEY FEES

The attorney fees were \$3,658.55.

D. DELCAMBRE WELL HARDWARE ACQUISITION

There were 3 other oil and gas companies who had an interest in the well besides Coastal States Gas Producing Co. The total list is given below:

- (1) Coastal States Gas Producing Co.
- (2) The Prudential Group
- (3) Columbia Gas Development Corp.
- (4) Union Oil of California

The four companies signed the act of sale document over a period of 3 months.

Coastal States and Prudential signed in December, 1975. Columbia Gas Development Corporation signed in January, and Union Oil of California signed on February 23rd.

VI (continued)

The disposition of funds was as follows:

COASTAL STATES _____	\$22,788.75
(the others 3) _____	<u>\$14, 711.25</u>
TOTAL	\$37,500.00

E. FEDERAL, STATE AND LOCAL LICENSES

I. FEDERAL AGENCIES

The only Federal agency which would require a permit is the U.S. Army Corps of Engineers.

Copies of the correspondence between "Geothermic Resource, Inc." and the Corps of Engineers may be found in Appendix F of this report.

A "waiver of objection" signed on April 28, 1976, was accepted by the Corps of Engineers to permit dredging of the barge slip which serves the Edna Delcambre et al No. 1 well.

The Environmental Protection Agency was contacted by Mr. James R. Hodges. Mr. Ken Houghman of the New Orleans office of EPA advised Mr. Hodges that the operation as described to him would not violate any of the EPA regulations. This was true, he felt, because the produced water would be disposed of in sub-surface salt water bearing sands. Noise and air pollution levels are expected to be below the federal and state requirements.

2. STATE AGENCIES

a) The Louisiana Department of Conservation

Two permits will be required for the project. One permit allows the drilling of the disposal well, and the other allows for the operation of the workover rig. These permits have been approved.

b) The Louisiana Mineral Board

The Louisiana Mineral Board informed our project engineer Mr. James R. Hodges, that even though state lands are involved that they require only a progress report of this project. No additional permits are required from this state agency.

c) The Louisiana Department of Public Works. No permits are required according to Mr. Arthur Theis, Chief Engineer, of the Department of Public Works. A letter of "no objection" has been requested. See Appendix E.

3. LOCAL AGENCIES

1) The Vermilion Parish Police Jury

A letter was received by Mr. Hodges from the Vermilion Parish Police Jury, dated April 21, 1976, stating that this agency had no objection to the operations planned by our project team at the well site. A copy of this letter may be found in Appendix F.

VI (continued)

2) The Abbeville Harbor and Terminal District

A letter from Mr. J.C. Vorhoff, Jr., President of the Abbeville Harbor and Terminal District, dated April 12, 1976, is reproduced in Appendix E. In this letter Mr. Vorhoff informed us that their agency has no objection to the dredging and maintenance operations at the well site.

3) The Delcambre Harbor and Terminal Authority

Mr. Hodges was informed that this agency had no requirements that would affect our operations at the well site.

VII STATIC TEST PLANS

When the first proposal to ERDA DGE was prepared by McNeese and OHRW (April 1975), it was contemplated that there would only be static testing of geopressured water. The problem of locating a suitable test well, and the scarcity of available wells, led to a proposal to do dynamic tests on the Delcambre No. 1 when it was offered in July of 1975. A comparison of costs between static and dynamic testing of this well pointed up the wisdom of proceeding with dynamic testing, which would supply more information about the resource. ERDA DGE agreed to proceed with dynamic tests in September.

The Final Report on this project will contain details of the procedure we would have followed had there been only static tests on the Delcambre No. 1 well.

VIII DYNAMIC TEST PLANS

A. DISPOSAL WELL

In order to protect the environment, the salt water obtained from the Delcambre No. 1 well will be reinjected below ground level at a depth of 2500 feet. After consultation with the Louisiana Department of Conservation, it was decided to use a salt water bearing sand at 2500 feet since sands between 1300 and 2700 feet were used by other operators who produced water associated with oil in the Tigre Lagoon oil field. These sands had received water at rates ranging between 10,000 and 20,000 barrels per day, according to past records. These considerations led us to choose a promising sand at 2500 feet since production rates expected from Delcambre No. 1 would be less than 20,000 barrels per day.

The procedures for drilling the disposal well are listed in items 1 through 40 in the next paragraph.

B. DYNAMIC TESTING PROCEDURE

A summary of major activities at the well site follows. The preparation of the site, the drilling of the disposal well, and all testing activities up to and including final disposition are included in the summary.

1. Dredge location and prepare site
2. Move rig in on disposal well location
3. Rig up
4. Drive 150' of 13 3/8" conductor
5. Nipple up blowout preventer & Hydril

VIII (continued)

6. Pressure test blowout preventer
7. Drill 9 5/8" hole to 2490' $\pm$
8. Run Spontaneous Potential and Caliper Log
9. Run 2480' $\pm$ of 7 5/8" casing
10. Cement casing
11. Wait on cement to set
12. Take off blowout preventer
13. Hang casing with Slip Seal Assembly
14. Hook up blowout preventers & Hydril & pressure test
15. Run in drill pipe and collars with 6 3/4" bit
16. Condition drilling mud to get rid of solids
17. Drill out to approx, 2580' w/6 3/4" bit
18. Circulate salt water to clean hole
19. Pull out of hole and remove bit
20. Go in hole open ended
21. Shut well in with Hydril
22. Pump salt water into lower formation
23. Run Pressure Draw-Down Test
24. Pull out of hole, hook up under-reamer
25. Run drill pipe into hole
26. Ream hole w/gelled water
27. Pull out of hole, remove reamer
28. Go into hole with open ended connection

VIII (continued)

29. Reverse circulate hole with gelled water
30. Pull out of hole and lay down drill pipe
31. Run Caliper log through open hole section
32. Go in hole with 3 1/2" tubing. TIW Pin Packer & Screen and set screen
33. Come out of hole with tubing
34. Go into hole with 3 1/2" tubing and stinger. Hang tubing
35. Nipple down blowout preventers
36. Nipple up tree
37. Pressure test tree
38. Pump salt water into disposal well to determine rates and pressures
39. Review possibilities of running draw-down test
40. Pump out barge and prepare to skid
41. Skid rig over Delcambre #1
42. Rig up
43. Run Temp. Log 13,300 to 12,000'
44. Run hole directional survey
45. Flow well to gauge tank. Record pressures and flow rates. Take samples for Lab.
46. Kill well with heavy mud, 18 lb/gal
47. Check for good seal in tubing, packer & casing
48. After well is killed, nipple down tree
49. Nipple up 7 1/16" blowout preventers and Hydril
50. Pressure test blowout preventers and Hydril

VII (continued)

51. Pull out of hole and lay down production string
52. Run Cement Bond, Gamma Ray, Thermal Decay Neutron and Collar Locator logs from 11,970' to 13,370'GL
(Gamma Ray and Thermal Decay Neutron required only to 13,050'GL)
53. Go in hole with tubing & 5 1/2" casing scraper to 13,278' ground level. Circulate to clean bottom of hole and pull out of hole.
54. Prepare to set wireline bridge plug
55. Set wireline bridge plug at 13,270' ground level
56. Go in hole with tubing open ended to top of bridge plug
57. Place 12 sacks 19 lb/gal cement with tubing on bridge plug
58. Pull tubing out of hole and wait for cement to set
59. Go in hole with wireline and tag bottom
60. Set wireline bridge plug on top of cement
61. Run production packer on wireline at approx. 12,700' ground level
62. Go in hole with test string and stinger
63. Circulate salt water to reduce head on plug to 6000 psi
64. Seat stinger in packer
65. Shut in well, check for pressure build up
66. Break off Kelly and check for flow
67. Pressure test casing to 12,000 psi (equivalent to bottom hole pressure)
68. Unseat packer
69. Reverse circulate heavy mud then close Hydril
70. Circulate salt water to reduce bottom hole pressure to 150 psi below reservoir bottom hole static pressure
71. Seat packer (Should have 4' of stinger in packer)

VIII (continued)

72. Go in hole with tubing gun and perforate #3 sand with 3 shots (1 shot per foot) 12,867 to 12,870' Kelly bushing
73. Pull out of hole with tubing gun
74. Nipple up for dynamic testing
75. Run bottom hole pressure and temperature recorders to measure bottom hole static pressure and temperature
76. Pull out of hole with pressure and temperature recorders
77. Produce well slowly to mud pits to clean well
78. Run bottom hole fluid sampler
79. Run spinner survey to check number of perforations open
80. Acidize well and flow to clean up if deemed necessary and shut well in
81. Go in hole with bottom hole pressure and temperature recorders
82. Open well to test equipment and stabilize flow rate
83. Check operation of all measuring equipment
84. Determine flow rate at which sand production occurs
85. Verify flow rate at which sand production occurs
86. Verify flow rate at which sand production occurs
87. Verify flow rate at which sand production occurs
88. Verify flow rate at which sand production occurs
89. Shut in well, run build up
90. Pull out of hole with pressure and temperature recorders
91. Shut in well
92. Collect down - hole fluid sample

VIII (continued)

93. Go in hole with tubing gun and perforate entire No. 3 sand section
94. Pull out of hole with perforating gun
95. Flow well to pits to clean up
96. Well to be acidized and flowed to clean up if so deemed necessary
97. Run bottom hole pressure and temperature recorders
98. Flow well to mud pit
99. Divert flow stream to test equipment
100. Start sampling at surface points
101. Check for sand production
102. Set flow rate
103. Start extended flow test. When adequate draw-down has occurred, shut in well. Take bottom hole sample during flow period.
104. Observe bottom hole pressure build-up
105. Notify ERDA that check point has been reached
106. Pull out of hole with pressure and temperature recorders
107. Stand by for ERDA Committee review
108. Kill well with heavy mud
109. Run Gamma Ray and Thermal Decay Time Log from 12,770' to 12,980' ground level and pull out of hole
110. Go in hole with packer plug
111. Set permanent plug in packer at 12,700' ground level
112. Place 12 sacks of 19 lbs/gal cement with tubing on plugged packer
113. Pull out of hole and wait on cement
114. Go in hole with wireline production packer. Set at 12,380' ground level and pull out of hole

VIII (continued)

- 115. Go in hole with test tubing and stinger
- 116. Circulate salt water to reduce head on plug to 6000 psi
- 117. Seat packer
- 118. Shut in well and check for pressure build up
- 119. Break off Kelly and check for flow
- 120. Unseat from packer
- 121. Circulate to salt water to reduce bottom hole pressure to 150 psi below reservoir bottom hole static pressure
- 122. Seat packer
- 123. Perforate No. 1 sand with 3 shots (1 shot per foot) 12,562' to 12,565' ground level
- 124. Pull out of hole with perforating gun
- 125. Nipple up for dynamic testing
- 126. Run bottom hole pressure recorders to measure bottom hole static pressure and temperature
- 127. Pull out of hole with pressure recorders
- 128. Produce well slowly to mud pits to clean well
- 129. Run bottom hole fluid sampler
- 130. Run spinner survey to check perforations
- 131. Acidize well and flow to clean up if deemed necessary and shut well in
- 132. Go in hole with bottom hole pressure and temperature recorders
- 133. Open well to test equipment and stabilize flow rate
- 134. Check operation of all measuring equipment
- 135. Determine flow rate at which sand production occurs

VIII (continued)

136. Verify flow rate at which sand production occurs
137. Verify flow rate at which sand production occurs
138. Verify flow rate at which sand production occurs
139. Verify flow rate at which sand production occurs
140. Shut in well and run pressure build up
141. Pull out of hole with pressure and temperature recorders
142. Collect down-hole fluid sample
143. Perforate entire No. 1 Sand section
144. Pull out of hole with perforating gun
145. Flow well to pits to clean up
146. Well to be acidized and flowed to clean up if so deemed necessary
147. Run bottom hole pressure and temperature recorders
148. Flow well to mud pits
149. Divert flow stream to test equipment
150. Start sampling at surface points
151. Check for sand production
152. Set flow rate
153. Start extended flow test. When adequate draw-down has occurred, shut well in. Take bottom hole sample during flow period.
154. Observe bottom hole pressure build up
155. Notify ERDA check point has been reached
156. Pull out of hole with pressure and temperature recorders
157. Stand by for ERDA committee review

VIII (continued)

158. If committee decides on extended testing, then new procedure will be written
159. After all testing has been completed, kill well with heavy mud
160. Run Gamma Ray, Thermal Decay Neutron log from 12,470' to 12,730' ground level
161. Go in hole with permanent packer plug
162. Place 12 sacks 19 lbs/gal cement on packer through tubing
163. Pull out of hole and lay down tubing
164. Plug and abandon well according to Louisiana standards
165. Skid rig to disposal well
166. Rig up kill well and remove well head
167. Unseat packer and spot 12 sacks of 19 lbs/gal cement on top of screen liner
168. Pull out of hole and lay down tubing
169. Plug and abandon disposal well according to Louisiana standards
170. Sell pipe and equipment
171. Release rig and equipment
172. Clean location

VIII (continued)

C. CHEMICAL ANALYSES

The methodology planned for performing chemical analyses is schematically shown in Figures 21 and 22. Six bottom hole samples from each of the sands to be tested (Nos. 1 and 3) were to be obtained at as near in situ conditions as possible. For this purpose the Reyburn Fluid Sampler, provided by Camco, will be used. The sampler has been designed to withstand pressures exceeding the 11,000 psi expected to be encountered at bottom hole conditions. (See Figure 22).

At least three of the bottom hole samples from each sand will be analyzed at McNeese Laboratories according to the scheme shown in Figure 22. The remaining samples will be held as back-up for future work, if needed.

The treatment of bottom hole sample No. 2 (Figure 22) requires some elaboration. The Reyburn (Camco) sampler, with its contained sample of reservoir fluid, will be transferred by Camco personnel into pressure bombs at the site. The transferred sample will be taken to Weatherly (or Core) Engineering Laboratories in Lafayette, Louisiana. The analyst will pressurize the sampler to a pressure exceeding the bubble point of the confined fluid, and then allow a metered amount to zero flash such that the volume of gas and water can be measured under controlled conditions, and collected. The gas sample will be retained for component analysis. The water sample will be transferred to McNeese laboratories for analysis of ionic content. The zero flash operation will give an accurate measure of the amount of gas dissolved in the brine, which is one of the most important bits of information to be obtained in the course of this project.

VIII (continued)

In addition to bottom hole samples, numerous samples of gas and liquid will be taken at the top of the hole at stations located on the test barge (see Figure 24). Water from the well head will flow through a sand detector, a metering station (pressure, temperature, corrosion coupon) and then through a choke manifold to reduce the pressure to 1440 psig. The main fluid stream passes on to the high pressure separator, but a slip stream from the choke passes on to a second choke (reducing pressure to approximately 25 psig). There is a sample point and monitoring station after this reducing choke. This station continuously records temperature, pH, and conductivity on a recorder housed in the quarters barge.

The gas leaving the high pressure separator passes into a low pressure separator (sometimes called the "scrubber") where the gas and any residual liquids are separated. The gas emerges from the top of the separator through a monitoring station (pressure, temperature, and volume). The station has a sample connection to allow the exit gas to be sampled enroute to a flare. The relative volumes of gas and liquid can be used as a check on the bottom hole sample, with respect to the volume of gas contained in a unit volume of water coming from the well.

The liquid stream from the high pressure separator passes through a monitoring station (pH, conductivity, and temperature) to the settling tank which primarily serves as a reservoir for the suction side of the pump which reinjects the brine into a disposal well. The brine leaving the injection pump discharge is monitored (pressure, temperature, and volume) before entering the injection well. A sample point is located in this monitoring station to sample the brine prior to being reinjected in the ground.

VIII (continued)

There is a slip stream of fluid taken from the monitoring station just downstream of the High Pressure Separator. This stream is cooled before passing through a monitoring station. In this station pH and conductivity are recorded continuously. The stream is filtered through a high pressure nucleopore filter containing a 0.40 micron membrane filter medium by which suspended solids are removed. A sample of the filtered fluid can be taken at this point.

There are two purposes for the cooling step; (1) to reduce the temperature to minimize steam flashing while the sample is taken, and (2) to minimize the precipitation of dissolved silicates. Most of the outside laboratories requesting water samples want the samples taken at this point, i.e., after the separator and after cooling. A partial list of laboratories requesting samples is given below:

1. The University of Texas at Austin, attention of Dr. Charles Kreitler, and also Dr. Lynton Land, of UTA Geology Dept., will assist in the analysis.

Their primary interest is in analyzing the isotopic composition of hydrogen and oxygen of the water, carbon of the carbonate and/or bicarbonate, and nitrogen in any ammonium ion that might be present.

2. Samples from the same location will be sent to USGS in Denver for radon and radioactivity measurements.
3. Freeport Sulfur company has requested a sample for analysis.
4. Battelle Northwest Laboratories will do trace heavy metals on a water sample.
5. University of New Orleans wants a water sample (Dr. John Laseter) for trace organic compounds.
6. USGS Laboratories of Menlo Park, California, (Dr. Yousif Kharaka) wants to analyze the water for aluminum ion and others of interest in studying geological clay deposits.

VIII (continued)

7. Gulf South Research Laboratories in New Orleans wants samples of both gas and liquids.

8. Bureau of Mines Laboratory at Amarillo, Texas, wants to analyze the gas for helium content.

IX CONCLUSIONS AND RECOMMENDATIONS

The most general conclusion growing out of the work to this point is that none of the parties (ERDA, McNeese, or OHRW Engineering) fully appreciated the magnitude of the task or the cost involved when the project began. Much wasted motion was experienced by ERDA in educating McNeese and OHRW Engineering in the policies and operating procedures of ERDA. The traffic also proceeded in the other direction since ERDA Washington and ERDA Oak Ridge needed to be educated in the operating procedures of the "oil patch" (the real world in which oil and gas are produced from deep reservoirs).

It is the recommendation of the authors that preliminary talks be held by all parties at the very early stages of any research project to learn as much of the anticipated problems (procedures, legal matters, etc.) as possible. This will probably be less of a problem in the future than in the past. Hopefully other geothermal projects of similar nature, involving "oil patch" type operations, will benefit from our experience.

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APPENDICES

A. WELL - BORE DIAGRAM

Figure 19. Present Well-bore

Figure 20. Proposed Well-bore for Geothermal Test

B. ANALYTICAL PROCEDURES "FLOW" CHARTS

Figure 21. Separator Samples

Figure 22. Bottom Hole Samples

C. BOTTOM HOLE SAMPLING DEVICE

Figure 23. Camco Fluid Sampler

D. DIAGRAM OF SURFACE EQUIPMENT AT TEST SITE

Figure 24. Surface Dynamic Test Equipment

E. CORRESPONDENCE WITH GOVERNMENTAL REGULATORY AGENCIES

FIGURE 19

Edna Delcambre #1

Present Wellbore Diagram

Tigre Lagoon

Vermilion Parish, Louisiana

FIGURE 20

Edna Delcambre #1

Geothermal Test Wellbore Diagram

Tigre Lagoon

Vermilion Parish, Louisiana

Note A: Additional samples will be collected for U.S. Geological Service, Battelle Northwest, University of New Orleans, University of Texas and others.

Note B: Hopefully, Rn, He, H₂S, and NH₃ can be determined on these samples also.

Note C: S²⁻, F⁻, Sr⁺⁺, Se⁺⁴, Na⁺, and K⁺ will be determined if conditions and budget considerations permit.

Note D: A complete analysis on every sample may not be necessary.

Note E: Other metals shown to be present by this technique may be determined if time and budget considerations permit.

Note F: In-line measurements of temperature, specific conductance and pH will be made and recorded.

BOTTOM HOLE SAMPLES

Analytical Flow Diagram

Figure 22

FIGURE 23

CAMCO FLUID SAMPLER

Volume of sample chamber approximately 650 ml.

Edna Delcambre #1

Surface Dynamic Test Equipment

Tigre Lagoon

Vermilion Parish, Louisiana

FIGURE 24

APPENDIX E

CORRESPONDENCE WITH GOVERNMENTAL REGULATORY AGENCIES

1. Abbeville Harbor and Terminal District

2. Louisiana Department of Public Works

JIMMIE VORHOFF, JR.
PRESIDENT

WILLIAM D. GOOCH
VICE-PRESIDENT

NOAH R. BROUSSARD
SECRETARY-TREASURER

ABBEVILLE HARBOR AND TERMINAL DISTRICT

VICTOR SCHRIEFER
COMMISSIONER

111 NORTH JEFFERSON STREET
TELEPHONE 318-893-2491

LEWIS FACIANE
COMMISSIONER

ABBEVILLE, LOUISIANA 70510

APRIL 12, 1976

*Geothermic Resource
File*

OSBORN, HODGES, ROBERTS ENGINEERING
P. O. BOX 53921
LAFAYETTE, LA. 70501

GENTLEMEN:

WITH REFERENCE TO YOUR PERMIT REQUEST OF MARCH 26, 1976.

WE WISH TO ADVISE THAT THE ABBEVILLE HARBOR & TERMINAL DISTRICT HAS NO OBJECTION TO GEOTHERMIC RESOURCES, INC. PROPOSED MAINTAINENCE DREDGING OF THE SLIP FROM THE MAIN CANAL TO WELLSITE, LOCATED IN SECTION 5, T14S-R5E, VERMILION PARISH, LOUISIANA.

PROVIDING THAT THE ABOVE MEETS WITH THE APPROVAL OF THE U. S. CORPS OF ENGINEERS AND THE LOUISIANA DEPARTMENT OF PUBLIC WORKS.

SINCERELY,

J. C. VORHOFF, JR., PRESIDENT
ABBEVILLE HARBOR & TERMINAL DISTRICT

JCV:RT

OSBORN • HODGES • ROBERTS • WIELAND ENGINEERING

BILL OSBORN, P.E.
JAMES R. HODGES
JAMES H. ROBERTS
DENTON R. WIELAND, Ph.D. P.E.

P.O. BOX 4266
NUMBER ONE OSBORN SQUARE OSBORN LANE
BRYAN, TEXAS 77801

PHONE: 779 - 2732
AREA CODE 713

September 28, 1976

Mr. Arthur Theis
Chief Engineer
Louisiana Department of Public Works
P. O. Box 44155
Capitol Station
Baton Rouge, Louisiana 70804

Re: Geothermic Resources, Inc., Edna Delcambre #1, Section
5, T 145, R 5 E, Tigre Lagoon Field, Vermilion Parish.

Dear Mr. Theis:

I have enclosed the plats that were submitted to the Corps of Engineers and two additional plats that show the location as it is now. We plan to do maintenance dredging from what is indicated as tide control gates, which are to be removed to the Delcambre #1 well site. The soundings that have been taken indicated that approximately 3000 cubic yards of spoil must be removed to prepare the location for the workover rig. It is planned to place the spoil resulting from the dredging on top of the existing spoil banks.

This canal was dredged originally by Coastal States Gas Producing Company for oil and gas exploration. They received a letter of "no objection" from the Louisiana Department of Public Works, dated October 23, 1967, which is enclosed.

Our program, sponsored by the Energy Research & Development Administration, an agency of the Federal Government, is designed to test and evaluate high pressure water reservoirs to determine the potential use for industrial power. Our activities are being monitored by several federal, state and local agencies, however, we are working closely with the Conservation Department whose Director of Geothermal-Geopressured Activities is Mr. Arnold Chauviere. One of our goals in performing our work is to keep all agencies of the Federal, state and local governments who have an interest in this work informed of the current activities and progress.

I am requesting from the Louisiana Department of Public Works a letter of "no objection" to the work that I have outlined. If you need additional information, I would be happy to supply whatever I can.

Sincerely yours,

James R. Hodges, P.E.
For the Partnership

OSBORN - HODGES - ROBERTS ENGINEERING	
EDNA DELCAMBRE #1 Geothermal - Temperature Test	
EXISTING SITE	
Date: 4/28/79	Sheet 1 of 8
Drawn by: DJC	
Approved by:	
C.B. Smith Co.

Schematic Vegetation Map of Well Site Area. BM - Brackish Marsh; LC - Location Canal; MP - Mud Pit; NB - Natural Bayou; SP - Spoil Bank Vegetation; TF - Tidal Flat; US - Unvegetated Spoil.

LEON GARY
DIRECTOR

STATE OF LOUISIANA
DEPARTMENT OF PUBLIC WORKS
BATON ROUGE 70804

October 23, 1967

Coastal States Gas Producing Company
P. O. Box 52088
Lafayette, Louisiana 70501

Attention: Mr. A. M. Cogbill

Gentlemen:

This office is in receipt of your letter dated October 19, 1967, together with drawings relative to dredging and drilling operations which you propose to perform to serve the Coastal States - Preston Oil Edna Delcambre et al No. 1 Well, located in Section 5, Township 14 South, Range 5 East, in South Tigre Lagoon Area, Vermilion Parish, Louisiana.

The above request has been examined by Mr. Thurman C. Morgan, District Engineer for this Department, and no objection is offered to the proposed operations provided that they are performed in accordance with the above mentioned letter and drawings.

Yours very truly,

HU B. MYERS
Chief Engineer

/mbw

cc - U. S. District Engineer
New Orleans, Louisiana
State Land Office
Wild Life and Fisheries Commission
Mr. Thurman C. Morgan
Vermilion Parish Police Jury
Abbeville Harbor and Terminal District

ROY AGUILLARD
DIRECTOR

State of Louisiana
DEPARTMENT OF PUBLIC WORKS
P. O. BOX 44155, CAPITOL STATION
BATON ROUGE, LOUISIANA 70804

October 5, 1976

BOARD OF PUBLIC WORKS
GEORGE CHANEY, CHAIRMAN
EMMETT A. EYMARD
P. P. VERRETT, SR.
RICHARD P. GIBSON
ROLAND CARTER

Geothermic Resources, Inc.
c/o Osborn, Hodges, Roberts, Wieland Engineering
P. O. Box 4266
Bryan, Texas 77801

Attention: Mr. James R. Hodges, P.E., For the Partnership

Gentlemen:

This office is in receipt of a letter from Osborn, Hodges, Roberts, Wieland Engineering, written on your behalf, dated September 28, 1976, together with drawings relative to maintenance dredging operations which you propose to perform to prepare the location for the workover rig to move on location to drill your Edna Delcambre, Well No. 1, located 3,507.8 feet south and 1,902.7 feet west of the northeast corner of Section 5, Township 14 South, Range 5 East, in Tigre Lagoon Field, Vermilion Parish, Louisiana.

The above request has been examined by Mr. Warren P. Beedle, District Engineer for this Department, and no objection is offered to the proposed operations provided that the work is performed in accordance with the above mentioned letter and drawings in four (4) sheets.

Provided also, that all logs, stumps, or other large debris unearthed in the dredging operations are buried beneath the bottom of the waterway or removed to a disposal area on land.

Yours very truly,

Arthur R. Theis

ARTHUR R. THEIS
Chief Engineer

HJP/cjh

cc: U. S. District Engineer
New Orleans, Louisiana
State Land Office
Wild Life and Fisheries Commission
Vermilion Parish Police Jury
Louisiana Stream Control Commission
Mr. Warren P. Beedle

APPENDIX F

LETTERS OF "NO OBJECTION" AND PERMITS

1. Vermilion Parish Police Jury
2. Corps of Engineers
3. Permit to Drill for Minerals

RIXBY MARCEAUX, SR.
PRESIDENT

JOHNNY GAUDET
VICE-PRESIDENT

JEWITT P. HULIN
SECRETARY-TREASURER

VERMILION PARISH POLICE JURY

MEMBERS

DISTRICT 1
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ROUTE 1 BOX 256
MAURICE, LA. 70555

DISTRICT 2
FRANK SPELL, JR.
ROUTE 1 BOX 326-A
MAURICE, LA. 70555

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MINOS BROUSSARD
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ERATH, LA. 70533

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321 JACQULYN ST.
ABBEVILLE, LA. 70510

DISTRICT 5
R. C. GASPARD
304 SO. ST. VALERIE
ABBEVILLE, LA. 70510

DISTRICT 6
JAMES DALE LANDRY
ROUTE 2 BOX 242-E
ABBEVILLE, LA. 70510

DISTRICT 7
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ABBEVILLE, LA. 70510

DISTRICT 8
CORBETT J. DOMINGUE
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ERATH, LA. 70533

DISTRICT 9
LEON DETRAZ
ROUTE 1 BOX 304
ABBEVILLE, LA. 70510

DISTRICT 10
RIXBY MARCEAUX
ROUTE 3 BOX 97
KAPLAN, LA. 70548

DISTRICT 11
OPHA TRAHAN
ROUTE 3 BOX 6-T
KAPLAN, LA. 70548

DISTRICT 12
RAY MORVANT
P. O. BOX 331
KAPLAN, LA. 70548

DISTRICT 13
WILBERT GASPARD
ROUTE 1 BOX 123-D
ABBEVILLE, LA. 70510

DISTRICT 14
MANSON SALTZMAN
ROUTE 1 BOX 24-D
GUEYDAN, LA. 70542

21 April, 1976

Mr. James R. Hodges
Secretary-Treasurer
OSBORN-HODGES-ROBERTS ENGINEERING
P. O. Box 53921
Lafayette, LA 70501

Dear Mr. Hodges:

Please be advised that the Vermilion Parish Police Jury by action of April 19, 1976 granted a letter of no objection to Geothermic Resources, Inc. for their operation in reference to Edna Delcambre et al #1 located in Section 5, T14S-R5E, Vermilion Parish, Louisiana, as per request of March 26, 1976.

Very truly yours,

Jewitt Hulin
Secretary-Treasurer

RDH

cc: Corps of Engineers

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P. O. BOX 60267
NEW ORLEANS, LOUISIANA 70160

LMNOD-SP (G)

23 April 1976

Geothermic Resources, Inc.
P.O. Box 53921
Lafayette, Louisiana 70501

Gentlemen:

Reference is made to your letter dated 30 March 1976 advising that Coastal States Gas Producing Company has assigned to you their rights under the authority of "Waiver of Objection" dated 30 October 1967. This waiver interposed no objection to dredging an extension to an existing canal in Section 5, T14S, R5E, in Vermilion Parish, Louisiana.

By letter dated 30 March 1976 Coastal States Gas Producing Company has confirmed this transfer.

This transfer of permit is final only when the party to whom the permit is being transferred (or his agent) signs and returns the attached copy of this letter to this office.

Sincerely yours,

C. W. DECKER
Chief, Permits and Statistics Branch
Operations Division

CF:

Coastal States Gas Producing Company Transfer of Permit Accepted.
Five Greenway Plaza East
Houston, Texas 77046

Permittee: _____
By: _____
Title: _____
Date: _____

*Attached copy was signed and
returned. 4/28/76 J.R.H.*

(91)

*Geothermic Reservoirs
File*

FORM MD-15-R-C
STATE OF LOUISIANA
DEPARTMENT

La ORIGINAL TO OPERATOR

CONSERVATION

NO. A-C
AMENDED PERMIT (Corrected)

Amend Operatg. & Well Name
AMENDED PERMIT TO DRILL FOR MINERALS (CORRECTED)

Serial No. 121964 Date April 23, 1976
Parish Vermilion Field Tigre Lagoon

Operator Geothermic Resources, Inc.*

Address P.O. Box 53921

City & State Lafayette, LA. 70501

Well Name Edna Delcambre** No 1

Location of Well: Sec. 5 T 14S R 5E

Location Same

*Formerly: Coastal States-Columbia Gas Dev.

**Formerly: Plan 6 SU A; E. Delcambre

Zone or Reservoir of Proposed Completion

Applicable Department of Conservation Order

[Signature]
COMMISSIONER

Joseph F. [Signature]
ISSUING AUTHORITY