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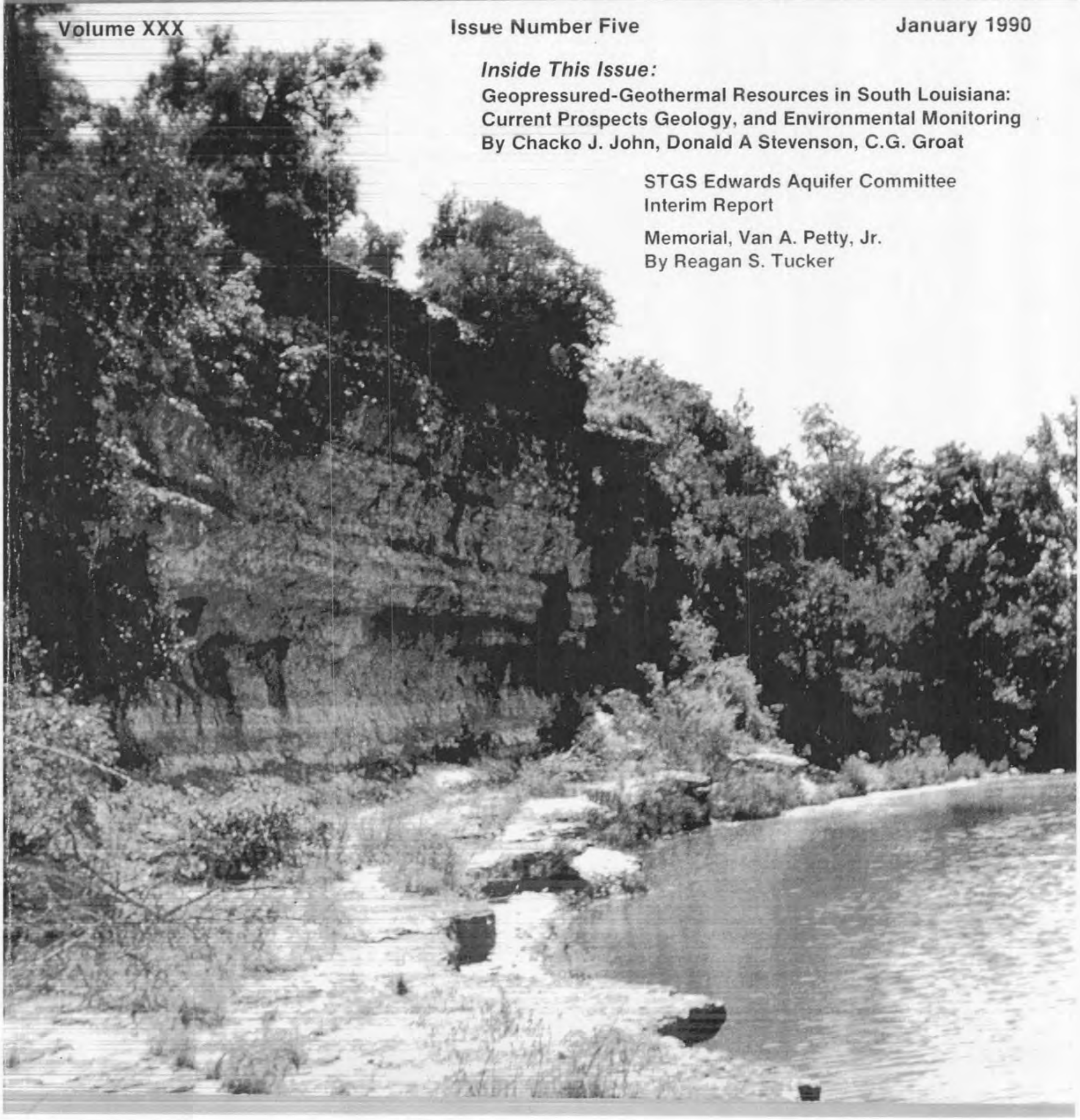

# GEOPRESSURED-GEOTHERMAL RESOURCES IN SOUTH LOUISIANA: CURRENT PROSPECTS GEOLOGY, AND ENVIRONMENTAL MONITORING

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## ABSTRACT

The northern Gulf of Mexico contains a large, potential geopressured-geothermal resource of natural gas dissolved in hot geopressured brine. The U.S. Department of Energy (DOE) has been investigating this resource under its ongoing geopressured-geothermal program, and there are currently three prospects, two in Louisiana and one in Texas, in various stages of developmental testing. The Gladys McCall #1 well (Cameron Parish, Louisiana), presently shut in to observe pressure build up, was drilled to a total depth of 16,510 ft. and plugged back to 15,831 ft. and had a maximum recorded temperature of 288°F. From perforations between 15,158 ft and 15,490 ft during a four-year testing period, it produced 27.3 million bbls of brine and 676 million scf of gas from brine at average production rates of 20,000 bbls/day. This lower Miocene brine-producing sandstone is part of a genetic unit of interconnected channel and point-bar sandstones originating in a lower shelf environment. The Gladys McCall #1 well is bounded to the north and south by faults, but is undefined on the east and west, due to lack of deep well control. The Superior Hulin #1 well (Vermilion Parish, Louisiana), originally drilled as a hydrocarbon prospect to a depth of 21,549 ft. It produced 0.3 BCF gas in 19 months from a zone between 21,059 ft. and 21,094 ft. It was later abandoned because of production problems and then transferred to DOE for testing under its geopressured-geothermal program. This well, which had a maximum recorded temperature of 338°F, was recently recompleted, plugged at 20,725 ft., and perforated between 20,670 ft. and 20,690 ft. for initial production testing that is scheduled to commence before the end of 1989. The section to be tested is a 570-ft-thick sandstone probably of submarine fan origin. Initial log analysis indicates that free gas in addition to solution gas may be present in different zones within the target section. The Pleasant Bayou #2 well (Brazoria County, Texas) is being flow-tested at a rate of approximately 20,000 bbls/day. It has a gas/brine ratio of approximately 23 SCF/STB and a temperature of 291°F. The potential of a geopressured-geothermal resource for generating electricity will be tested at the Pleasant Bayou site where an electric energy conversion system has been set up. Another potentially near-term use for a geopressured-geothermal resource, yet untested, is the use of hot brines to aid secondary hydrocarbon recovery in depleted fields containing wells penetrating thick geopressured sandstone reservoirs.

Gas-separated brine is disposed of by subsurface injection. Associated with the production and disposal of huge volumes of geopressured-geothermal brine are the environmental concerns of possible land surface subsidence, fault activation, and contamination of freshwater aquifers. An environmental monitoring program to address these issues has been set up around each test site. Land subsidence and fault activity attributable to geopressured-geothermal testing are being monitored with the aid of four or five continuous microseismic recording stations at each site (the first of its kind in the Gulf Coast region) and periodically surveyed first-order benchmark networks tied to National Geodetic Survey regional networks. Water samples taken periodically from surface stations and groundwater observation wells around each test site are analyzed for possible contaminants originating from geopressured-geothermal production testing and development operations. Data have been collected and analyzed before, during, and after testing. Environmental monitoring of the geopressured-geothermal test sites has so far not shown any long-term detrimental effects.

## INTRODUCTION

Sedimentary basins with rocks containing pore fluids under higher-than-normal confining pressures are known to exist in many areas around the world. The normal pressure-depth gradient for the Gulf Coast is 0.465 psi/ft, and higher pressures are considered abnormal (Harkins and Baugher, 1969). The energy contained in these geopressured rocks is termed geopressured-geothermal energy. In other words, geopressured-geothermal aquifers are underground reservoirs of hot pressurized brine, saturated with dissolved methane at the temperature, pressure, and salinity of the formation. Recoverable natural gas from the geopressured-geothermal resources of the northern Gulf of Mexico basin is estimated to be approximately 250 Tcf, equivalent to about 137% of known conventional methane reserves in the United States (Dorfman, 1988).

Geopressured-geothermal aquifers contain three forms of energy: (1) chemical energy: methane dissolved in brine under pressure; (2) thermal energy: hot brines with temperatures ranging from 250°F to 350°F or more, which could be utilized for direct heating or secondary hydrocarbon recovery; and (3) mechanical energy: high brine flow rates (35,000-40,000 bbls/day) and high well-head pressures (2,500-6,000 psi) could be used for driving turbines to generate electricity (Division of Geothermal Energy, 1980). The ideal geopressured-geothermal resource system would be a total energy system in which all three associated forms of energy---chemical, thermal, and mechanical---are utilized. However, such a system is still a long way from realization.

Numerous methods for the recognition, evaluation, and prediction of abnormal pressures are discussed in the literature on the subject (Fertl, 1976). Commonly attributed causes for the generation of abnormal pressure are continuous rapid sedimentation accompanied by subsidence, incomplete compaction of sediments, growth faulting, and the digenesis with chemical alteration of clay minerals due to heat and compaction expelling water in the process (Burst, 1969; Barker, 1972; Dickinson, 1953; Flanigan, 1981).

This paper is a summary report of the current work at the Louisiana Geological Survey, Louisiana State University, which is funded by the Department of Energy's (DOE) ongoing geopressured-geothermal energy program. There are five main research objectives for the DOE program:

1. Resource definition. This includes the identification of geopressured fairways through regional geologic work, the delineation of prospect areas, the selection of test well sites, and the establishment of a geologic and engineering database.

2. Demonstration of energy potential. This comprises the evaluation of the technical and economic feasibility of producing energy from geopressured-geothermal aquifers and developing knowledge about brine aquifers, including their size, long-term production capability, brine chemistry, temperature, pressure, reservoir engineering, geologic models, etc.

3. Development of disposal methods for large volumes of gas-separated brine by subsurface injection.

4. Determination of and search for solutions to environmental problems such as land subsidence, fault activation, and water quality.

5. Identifying and proposing solutions to legal and other institutional problems that may arise if commercial development of the resource is undertaken (Division of Geothermal Energy, 1980).

## REGIONAL GEOLOGY

Because of the Gulf of Mexico's prominence as a prolific producer of hydrocarbons, the structure and geologic history of the basin along the coasts of Louisiana and Texas is well documented (Bornhauser, 1958; Williamson, 1959; Rainwater, 1967, 1968; Caughey, 1975; Woodbury, 1973). The Gulf Coast basin has a sediment thickness of over 6 mi (Rice, 1980), brought in and deposited by large river systems since early Tertiary time. Sediment depocenters have shifted laterally and vertically in space and time depending on the prevailing climate, tectonics, and sediment supply. Rapid sedimentation was accompanied by subsidence and growth faulting (Ocamb, 1981), with the oldest growth-faulted and geopressured sediments being deposited seaward of the lower Cretaceous shelf margin (Bebout, 1981) (Figure 1).

The Tertiary and Quaternary sediments of the Gulf Coast basin have been broadly classified into three main facies based on sandstone percentages within the section (Thorsen, 1964; Norwood and Holland, 1974). These facies are: (1) massive sandstone facies, in which the sandstone composes 50% or more of the total volume of the section; (2) alternating sandstone and shale facies where only 15-35% of the section is sandstone; and (3) massive shale facies, with less than 15% sandstone in the section.

The abnormally pressured Cenozoic sedimentary formations in this area occurring over 10,000 ft below the surface and having temperatures above 225°F (Matthews, 1980) contain the largest potential for geopressured-geothermal energy resources. Figure 1 shows the area covered by the geopressured zone in the northern Gulf of Mexico basin. The regional geological framework necessary for the identification of potential geopressured-geothermal prospects was established by research conducted at the Louisiana Geological Survey by D.G. Debout (1982) and others (Bebout and Gutierrez, 1981; Wallace, 1982). The data obtained and evaluated in that program provided information on the subsurface structure, regional sandstone distribution, porosity, permeability, temperature, formation pressures, and salinity. The distribution and depths to the top of the geopressures sandstones in south Louisiana are shown in Figure 2. Most of the geopressured sandstone aquifers in the area occur at a depth of 12,000-15,000 ft or greater. In general, regional geologic studies have shown that the top of geopressure in the Texas Gulf Coast area occurs at depths between 7,000 ft and 12,000 ft. Northeast into Louisiana it deepens to 9,000-18,000 ft. In the geopressured zones, subsurface temperatures of 300oF occur at depths of 13,000-15,000 ft in west Louisiana and the east Texas Gulf Coast area, and at 15,000-18,000 ft in east Louisiana. While porosity generally decreases uniformly with depth (Loucks et al., 1979), it is not uncommon to see wide local variations in porosity and permeability at any particular depth because of variations in original sand composition, fluid movement and chemistry, geopressure, temperature, and effects of digenesis (John, 1988). Highly variable salinities ranging from 100,000 ppm to under 20,000 ppm have been found in the geopressured zones in different areas (Bebout and Gutierrez, 1981).

## CURRENT PROSPECTS

Three DOE geopressured-geothermal prospects are in various stages of developmental testing. Gladys McCall #1 well and Superior Hulin #3 well are in Louisiana, and Pleasant Bayou #2 well as in Texas (Figure 3). The Gladys McCall well was tested for four years and is presently shut in; the Superior Hulin well, a former gas well which has just been recompleted, is expected to begin in late 1989; the Pleasant Bayou well is being tested and is producing about 19,000 bbls/day of brine with a gas/brine ratio of approximately 23 SCF/STB and with a brine temperature of 291°F (Eaton Operating Co., Inc. 1989). Only the two South Louisiana prospects will be discussed in this summary paper.

## GLADYS MCCALL PROSPECT

The Technadril-Fenix and Scisson-Department of Energy (TF&S-DOE) Gladys McCall #1 well is located in Section 27, T. 15 S., R. 5 W., east of the town of Grand Chenier in a marsh area about 2.5 miles south of Louisiana 82 (Cameron Parish, Louisiana). It was drilled in 1981 to a depth of 16,510 ft and plugged back to 15,831 ft. The well location was based on preliminary regional and local geologic studies of this area done by the Louisiana Geological Survey (Bebout, 1982) and by Magma Gulf Company. These studies showed that this area had some of the thickest geopressured sand sections in South Louisiana. The occurrence of fluvio-deltaic clastic regression across the shelf break was postulated by Brunhild (1984) as a possible reason for the greater thickness of sandstones in this area. The Gladys McCall test well, drilled in the Miocene geopressured trend, penetrated the Miocene section from 4,000 ft to total depth and is geopressured below 14,400 ft. Approximately 1,150 ft of net sand was observed in this well from 14,412 ft to 16,320 ft.

A structure map of the prospect area is shown in Figure 4 (Technadril-Fenix and Scisson, 1982). The geopressured reservoir system is fault controlled to the north and south, but because of a lack of deep-well control, the reservoir's east-west dimensions are poorly defined. Because the test well is located in the Rockefeller Wildlife Refuge area, available seismic data is limited. There are tentative plans to purchase seismic data in the near future that will enhance the understanding of the areal extent of the reservoir, in addition to providing more accurate representation of faults on the structure map. A dip cross section of the area passing through the Gladys McCall test well is shown in Figure 5. The log correlations are relatively straightforward up to 15,000 ft, after which they become more complex. Two key microfossils, Cristellaria A (11,100) and Siphonina davisi (16,440 ft), mark the upper and lower boundaries of the target section in this well and are characteristic of the outer shelf and upper slope environments, respectively. These findings indicate that the sediments were deposited in a shelf environment by distributary channel systems. Details of the log correlations are provided in BeBout (1982) and John (1988).

The target section extending from 15,160 ft to 15,860 ft is made up of interconnected channel and point-bar sandstones which originated within the same channel system and which represent a genetic unit of sandstones. Hence, though on the electric log they may appear as possibly different sandstones, they may behave as a single interconnected body fluid communication during high-volume brine production. For purposes of reservoir modeling, using the thickness of genetic units of sandstones rather than what appear to be separate reservoir sandstones on the logs may provide a more accurate estimate of reservoir production and lon-

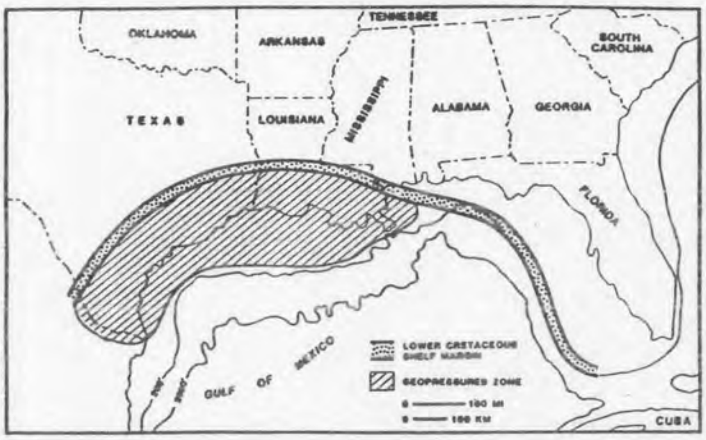

Figure 1. The area covered by the geopressured zone in the coastal areas of Louisiana and Texas (adapted from Bebout, 1982).

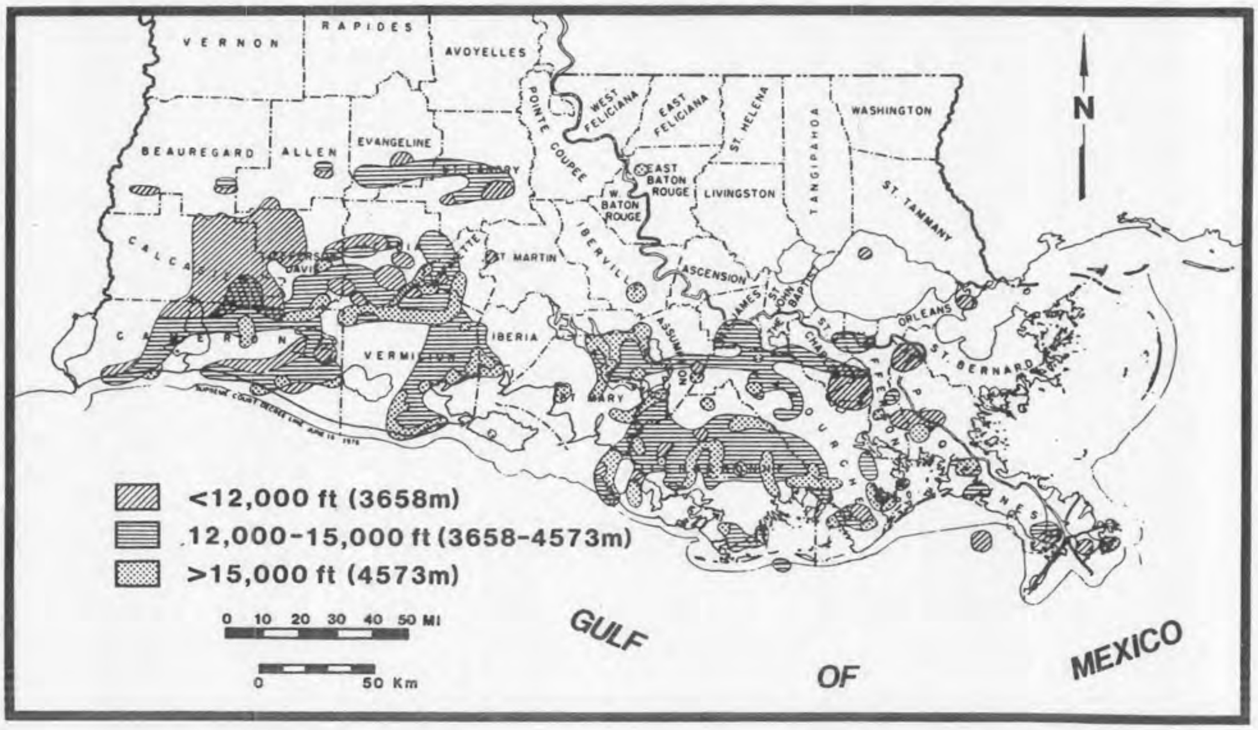

Figure 2. Distribution of, and depths to, Tertiary geopressured sandstones in South Louisiana (adapted from McCulloh et al., 1982).

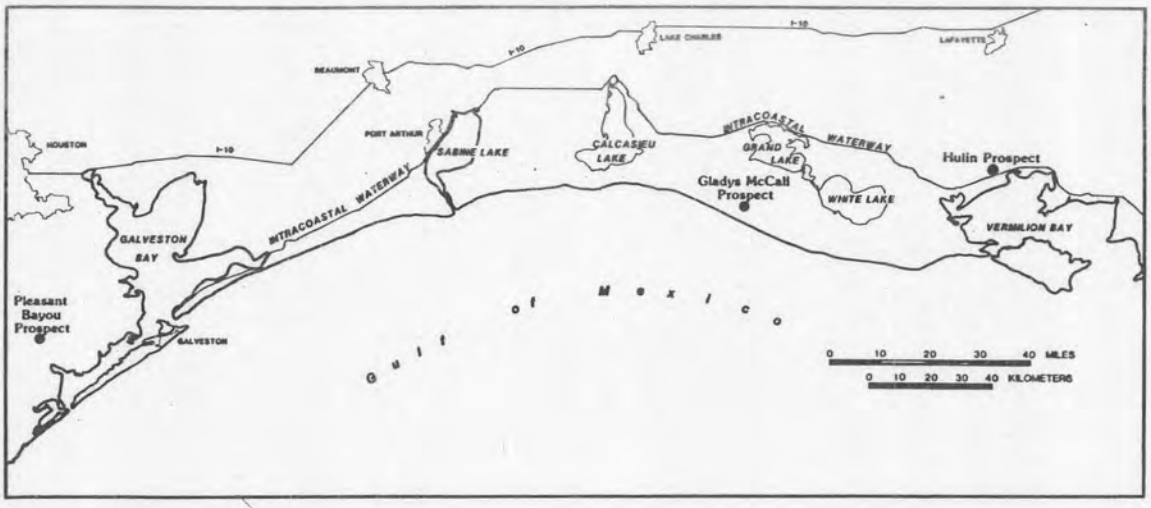

Figure 3. Map showing location of the three current geopressured-geothermal prospects: Gladys McCall and Hulin wells (Louisiana) and Pleasant Bayou well (Texas).

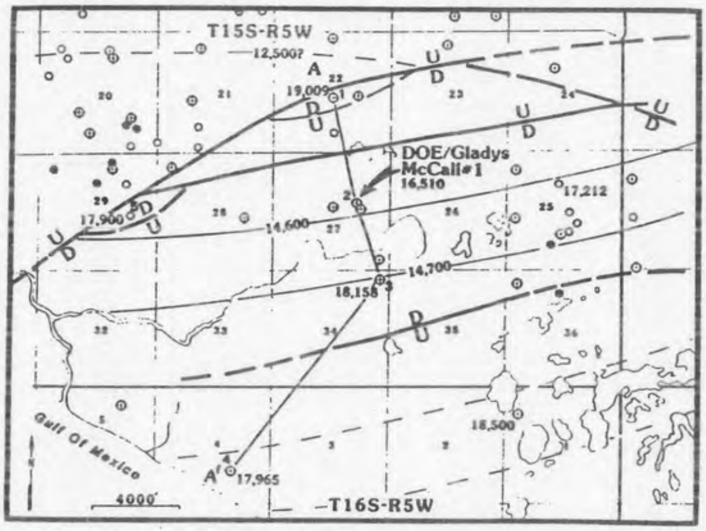

Figure 4. Structure map of the Gladys McCall prospect area (adapted from Technadril-Fenix and Scisson, 1982). A-A' is the line of cross section for Figure 5.

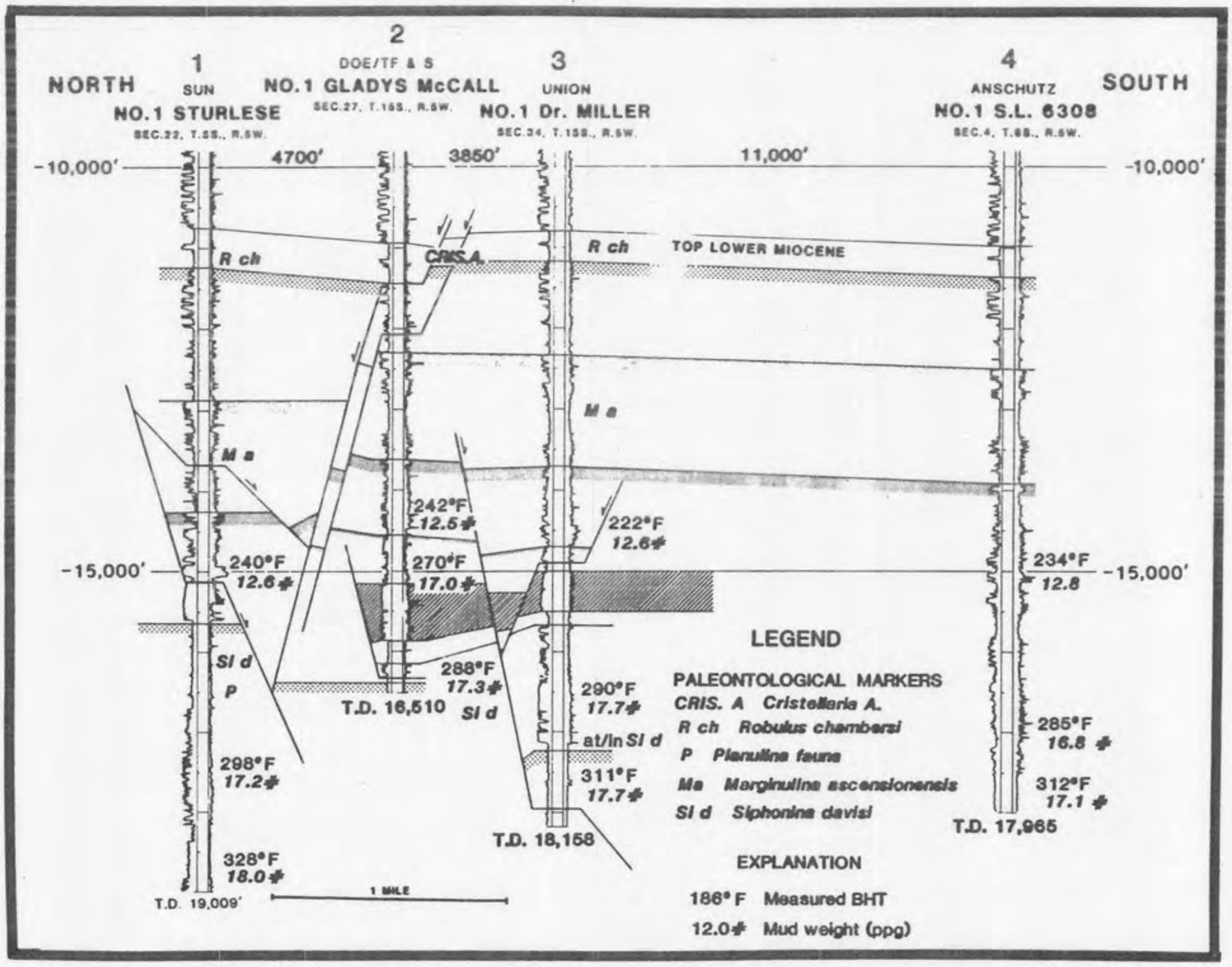

Figure 5. Dip cross section (north-south) of the prospect area. The line of cross section is shown in Figure 4 (adapted from Bebout et al., 1983).

gevity (John, 1988).

In the Gladys McCall test well 11 potential production zones (Figure 6) were defined before testing began. Analysis of three diamond cores (15,167-15,177 ft; 15,179-15,192 ft; and 15,348-15,374 ft) and of 28 sidewall cores shot between 15,460 ft and 16,455 ft showed the reservoir to be made up of fine-grained, well-consolidated, and silica-cemented sandstone (Technadril-Fenix and Scisson, 1982). No sand was produced during testing. Only zones 8 and 9 (Figure 6) were flow tested. Zone 9 produced 119,000 bbls of brine and 3.4 million SCF gas from perforations between 15,508 ft and 15,636 ft during short-term testing. The brine temperature was 298°F; original reservoir pressure, 12,936 psi; porosity, 24%; permeability, 90 md; total dissolved solids, 95,500 ppm; and the brine/gas ratio was about 32 SCF/STB. After zone 9 was plugged, zone 8 was tested for almost four years, beginning December 1983, before being shut in to observe pressure build up. Zone 8 brine temperature was 288°F; original reservoir pressure, 12,821 psi; porosity, 22%; permeability, 130 md; total dissolved solids, 94,000 ppm; and the gas/brine ratio was approximately 31 SCF/STB (Technadril-Fenix and Scisson, 1985). At the time of being shut in, the well had produced over 27 million barrels of brine and 676 million scf of gas from the brine. The gas-separated brine was disposed of by subsurface injection through a brine disposal well in proximity to the test well. The brine disposal well was drilled in 1965 to test for hydrocarbons to a depth of 15,598 ft and was later re-entered and completed at 3,514 ft for use as a brine disposal well.

During the test period the well was flowed at various rates ranging from 36,500 to 5,000 bbls/day for different lengths of time. The average rate of production was 20,000 bbls/day. Scaling problems encountered during initial production were successfully overcome on two occasions by injection of phosphorous pills. Figures 7 and 8 show cumulative production of brine and gas, while Figure 9 shows the daily production rates of brine during the years 1986 and 1987. Long-term, high-volume brine production can cause fractures and subsurface faults related to volume depletion and stresses that may be associated with production. This could further facilitate fluid flow between reservoirs that may have been originally separate and hence could enhance the producing reservoir's longevity.

## HULIN PROSPECT

The Superior Hulin #1 well is located in Section 2, T. 14 S., R. 4 E., approximately seven miles south of the town of Erath in Vermillion Parish, Louisiana. This exploration well was drilled by Superior Oil Company in 1978 to a depth of 21,549 ft. The maximum recorded temperature was 338°F. The well produced a 0.3 BCF gas during a period of 19 months from perforations between 21,059 ft and 21,094 ft. Because of production problems and an apparent packer or tubing/casing failure, Superior Oil Company abandoned the well and it was later transferred to DOE for testing under its geopressured-geothermal program. In November 1988, Eaton Operating Company, Inc., Houston, Texas, under contract to DOE, began operations to clean and recomplete the well, to correct problems that were causing a pressure build up, for use as a geopressured-geothermal test well. The well was completed in February 1989 and plugged back to 20,725 ft, just below the geopressured sand section of interest. Long-term testing of this well is scheduled to begin late in 1989.

Figure 10 shows a structure map of the Hulin prospect area contoured at the top of the lower Planulina section (approximately 15,400 ft in the Hulin well). As seen on the map, the Erath field is situated to the north of the Hulin well, the Boston Bayou field is located to the south, and the Tiger Logoon field lies to the northeast. All these fields are separated from the Hulin prospect by major down-to-the-basin growth faults. The western limit of the reservoir is presently undefined. Figure 11 is a dip cross section through the Hulin prospect area. The Hulin well is the deepest well in the area, and sections correlatable to the target section in the Hulin well have not been penetrated by any other wells in the vicinity. It is therefore difficult to determine details about the depositional environment and stratigraphic-structural relationship of the geopressured target section. Recently purchased seismic data over the Hulin prospect area combined with available geologic data will lead to a better understanding of the structure, the reservoir limiting boundaries, and the depositional environment of the Hulin geopressured-geothermal reservoir.

The geopressured section to be tested is shown in Figure 12. The bottom 20 ft (20,670-20,690 ft) have been perforated, and initial production testing will be from this section. As testing proceeds and each zone is completely evaluated, the section gradually will be perforated upwards. Regional geologic work done by Conover (1987) and Hamlin (1988) have indicated that the geopressured sands to be tested in the Hulin well (20,120-20,690 ft) represent canyon sandstone facies. It is also possible that the sands are part of a delta deposited in an unstable (subsiding) shelf area--which could account for the thick-

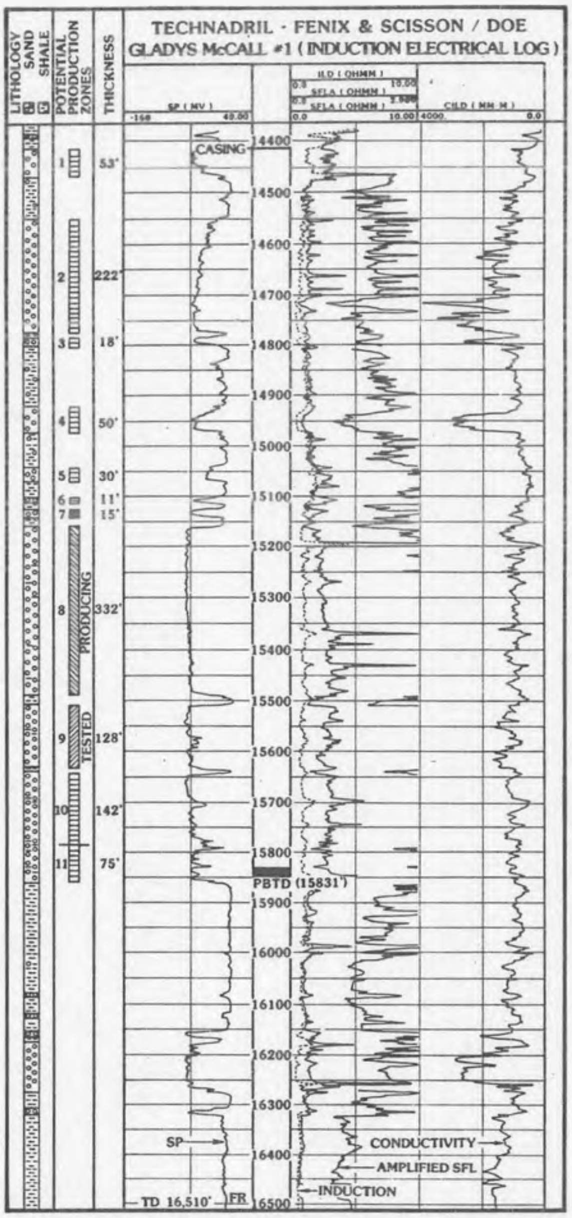

Figure 6. Electric log, potential production zones, and generalized lithology of the Gladys McCall test well (John, 1988).

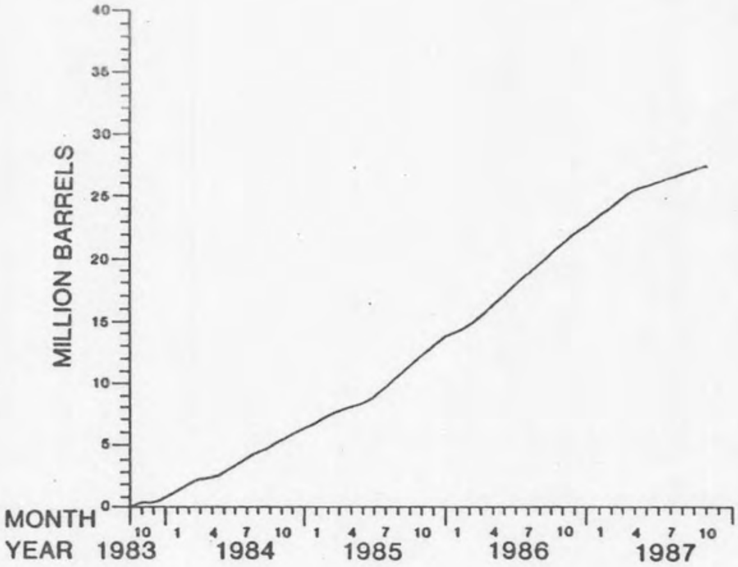

Figure 7. Graph showing the cumulative production of brine during the test period at Gladys McCall (data from Eaton Operating Company, 1987).

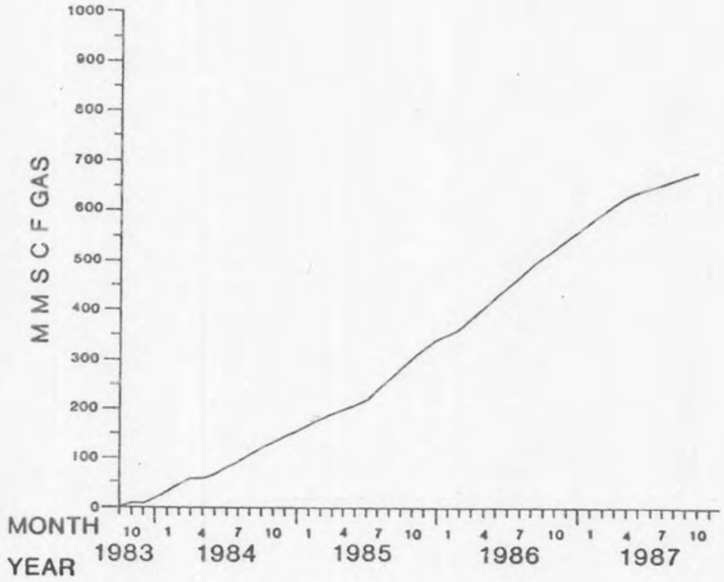

Figure 8. Graph showing the cumulative production of gas separated from brine during the test period at Gladys McCall (data from Eaton Operating Company, 1987).

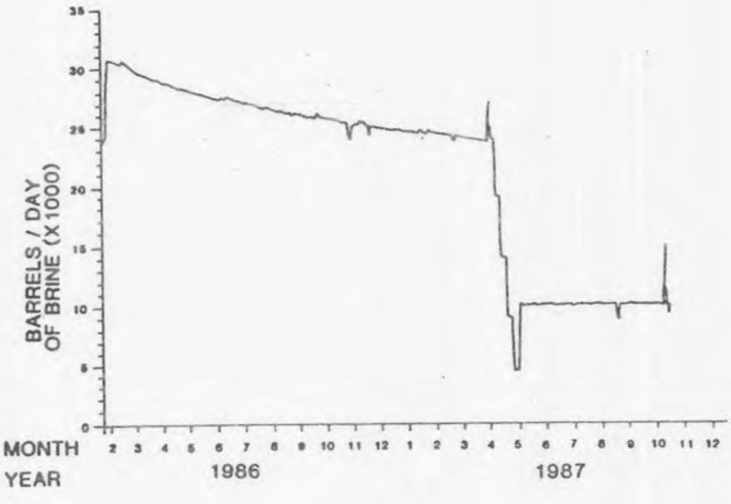

Figure 9. Graph showing the daily production of brine during the last two years of testing at Gladys McCall (data from Eaton Operating Company, 1987).

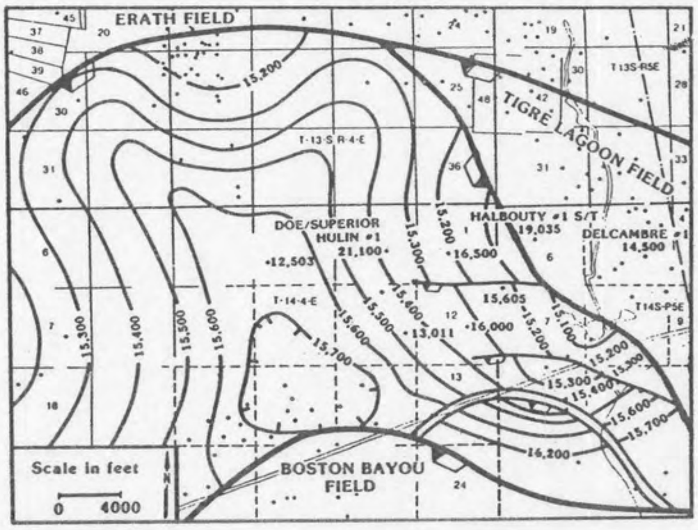

Figure 10. Structure map of the Hulin prospect area (Vermilion Parish, Louisiana) contoured at the top of the lower *Planulina* section in the Hulin well. (adapted from U.S. Department of Energy, 1986).

ness of the sandstone.

Results of log interpretations by the University of Texas, Petroleum Engineering Department, indicate that the sandstone to be tested may contain free gas in addition to solution natural gas at several zones within the section. Additional free gas will provide more income from gas sales, making the operation more economic. Other possible near-term utilizations of such geopressured-geothermal resources include enhanced secondary hydrocarbon recovery using methane depleted brine, direct heating and electricity generation.

## ENVIRONMENTAL MONITORING

The chief environmental concerns associated with the testing and development of geopressured-geothermal resources are land surface subsidence, growth fault activation, and water quality impacts. The production of large volumes of brine, causing volume depletion, compaction of subsurface reservoirs, and alteration of the subsurface pressure regimes could lead to subsidence, microearthquakes, and fault reactivation. Subsidence and fault movements cause damage to buildings, pipelines, roads and levees. In coastal areas, subsidence would cause inundation by tidal waters and generally increase the potential for flooding. Large volumes of highly concentrated brine (total dissolved solids in excess of 80,000 mg/l), if discharged into surface water, can harm the soil and/or totally destroy the flora and fauna in the vicinity of the discharge point. It would also render the water unfit for use. The geopressured-geothermal brines are diposed of by subsurface injection through shallow disposal wells into saltwater aquifers isolated from the freshwater aquifers above. Even in this case there exists the possibility of surface contamination from spills. The upward migration of injected brine could contaminate fresh groundwater aquifers, thus making the water unsuitable for domestic, agricultural, and industrial use.

The ongoing environmental monitoring program at the geopressured-geothermal test well sites consists of microseismic, subsidence, and water quality monitoring. Continuous microseismic recording stations are set up at the Gladys McCall, Hulin, and Pleasant Bayou prospect areas. These stations are the first of their kind in the Gulf Coast region. Figure 13 shows the microseismic stations and benchmark locations presently established at the Hulin site to monitor fault activity and subsidence. Each network consists of four short-period, vertical-motion seismometers installed in boreholes ranging from 30 ft to 150 ft deep, depending on location, to reduce surface interference. The seismic signals from each site are amplified and transmitted through telephone lines to the Louisiana Geological Survey's seismological laboratory at Baton Rouge, where they are continuously recorded on tape and drum recorders. Paper-drum records are examined daily for any evidence of seismic activity at the different sites. The lack of historical background data for comparison has hampered the identification and interpretation of some recorded signals. Many different and curious signal characteristics have been identified in the microseismic data recorded so far. Geophysical blasting, sonic booms, thunderstorms, and movement of vehicles, in addition to distant teleseisms from all over the world, have been recorded. Two small seismic events (magnitude .0) near the Gladys McCall test site were recorded on February 14 and October 24, 1985, and these may have been influenced by brine production and disposal (Van Sickle et al, 1988). No other microseismic activity attributable to geopressured-geothermal testing has so far been recorded at any of the current prospect sites. Figure 14 is a seismogram showing geophysical blasting, vehicle movement, and signature from the Lake Charles earthquake of October 16, 1983.

Field measurements have been made around each test site to determine baseline rates of subsidence in each area before well testing and to monitor land surface elevation changes during and after well testing. Networks of closely spaced, first-order elevation benchmarks have been installed at all the current prospect sites (Figure 13). These benchmarks have been surveyed and tied, where possible, to the nearest National Geodetic Survey (NGS) regional vertical control network, which is periodically resurveyed by the NGS. Each benchmark consists of a steel rod driven to 100 ft or to refusal (Figure 15). Relative elevation changes of a few millimeters or more can be determined by repeated surveys of these subsidence monitoring benchmark networks and by comparison with previous surveys and the reference elevation of a NGS benchmark in a "stable region." In the Gladys McCall prospect area, some subsidence was noted along the well access road to the drill site a year before testing began. This was attributed to the movement of heavy drilling equipment brought in to the site for drilling and well development (Van Sickle et al., 1988). Apart from this, no subsidence related to well testing and development has so far been observed at any of the current prospect sites.

Water quality monitoring was established at the geopressured-geothermal prospect sites to deter-

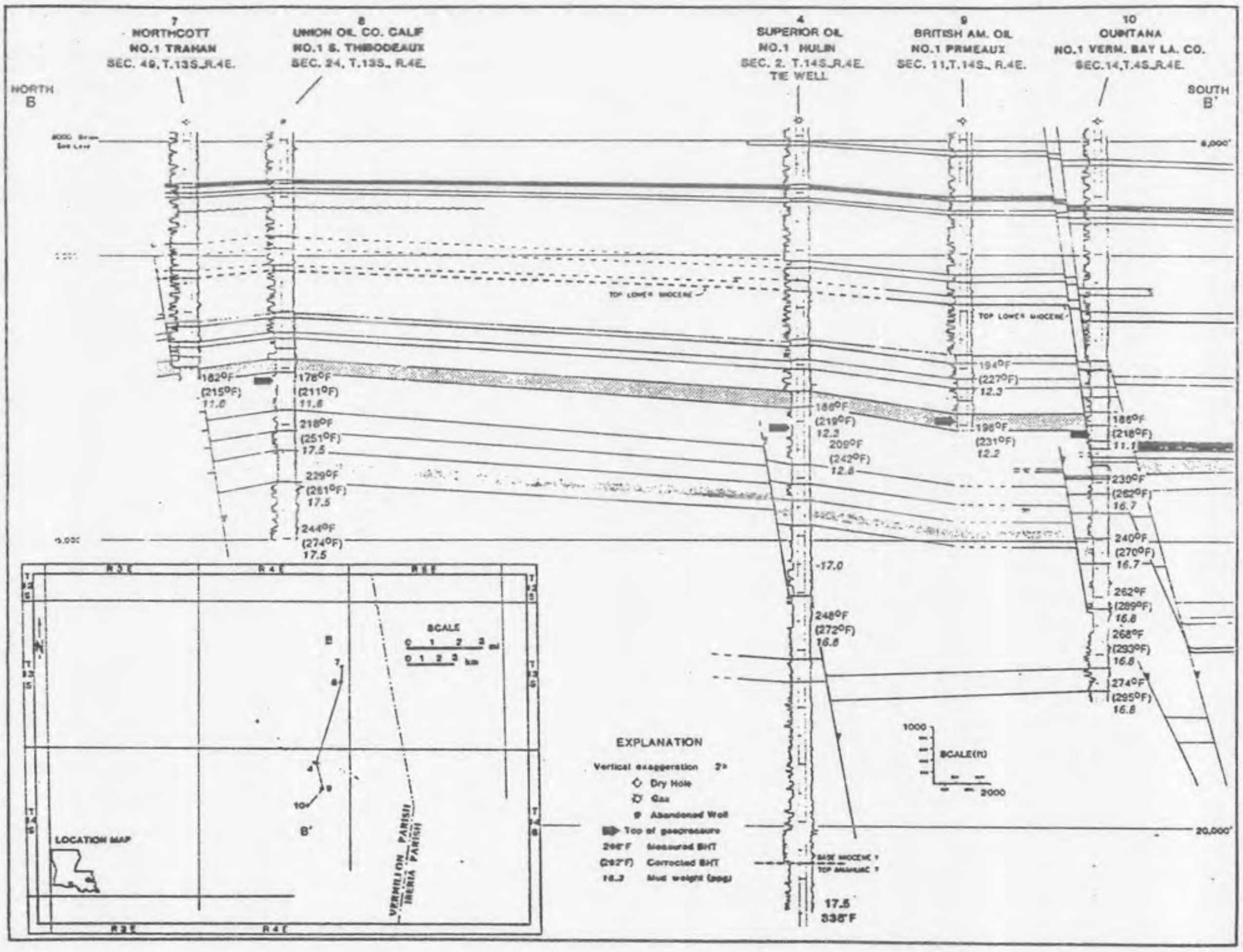

Figure 11. Dip cross section B-B' through the DOE/Superior Hulin #1 well (adapted from McCulloh and Pino, 1983).

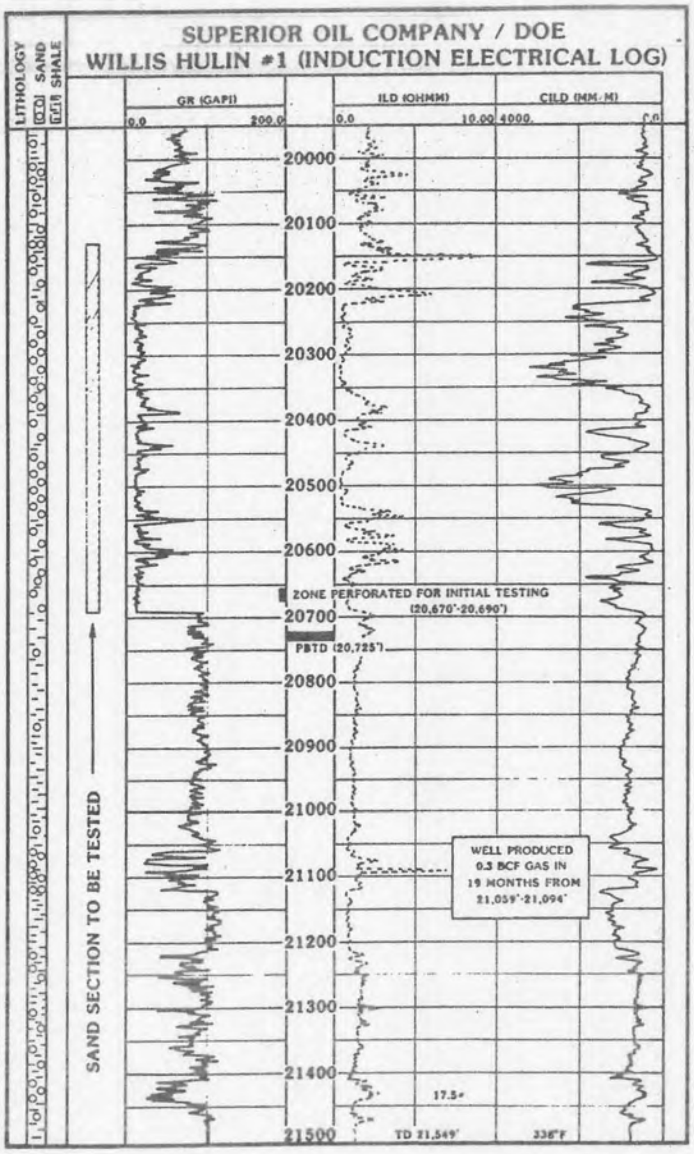

Figure 12. Electric log showing the sand section to be tested and generalized lithology of the Hulin test well.

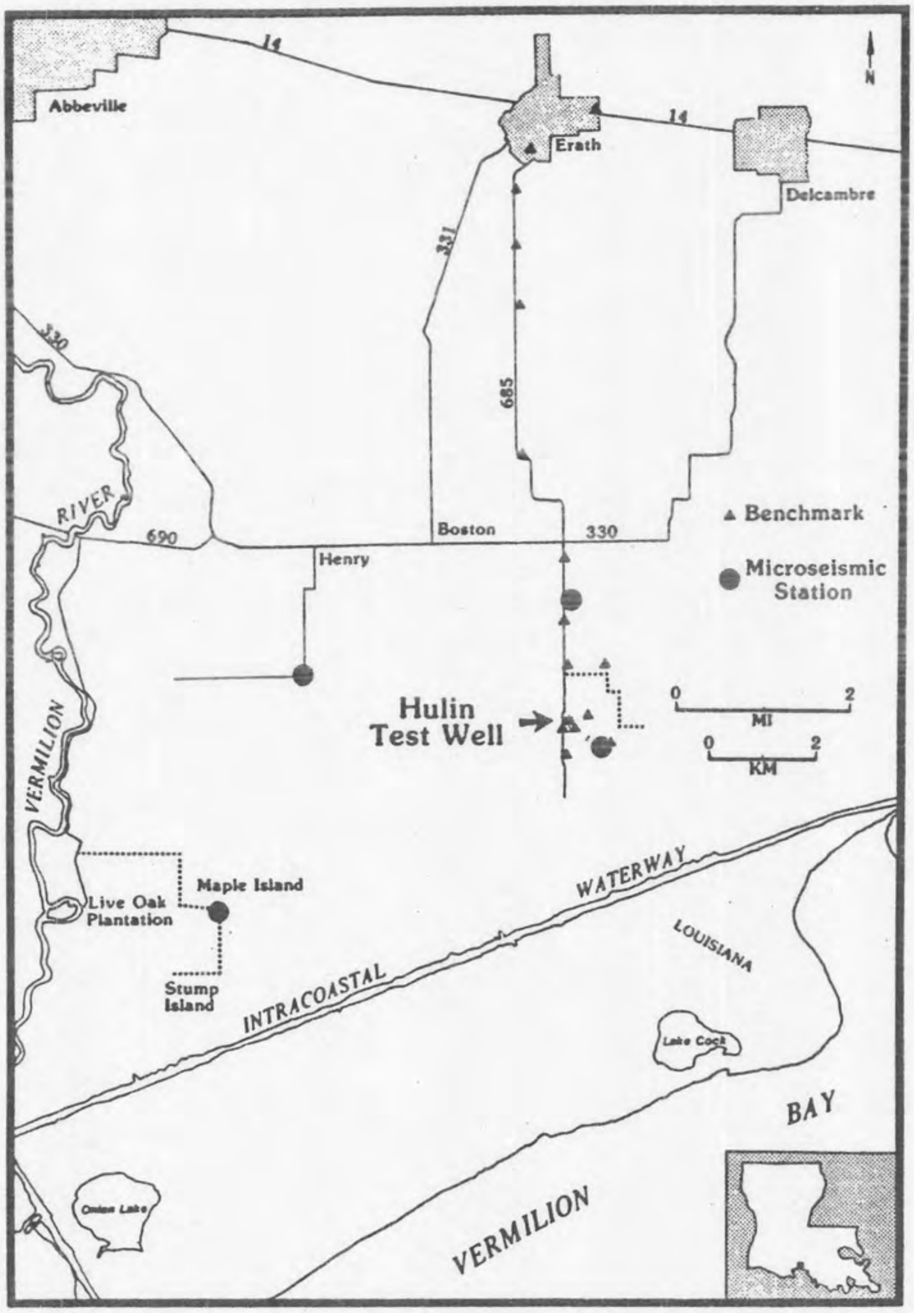

Figure 13. Locations of microseismic stations and benchmarks established at the Hulin test site to monitor fault activity and subsidence that may be caused by production testing of the well.

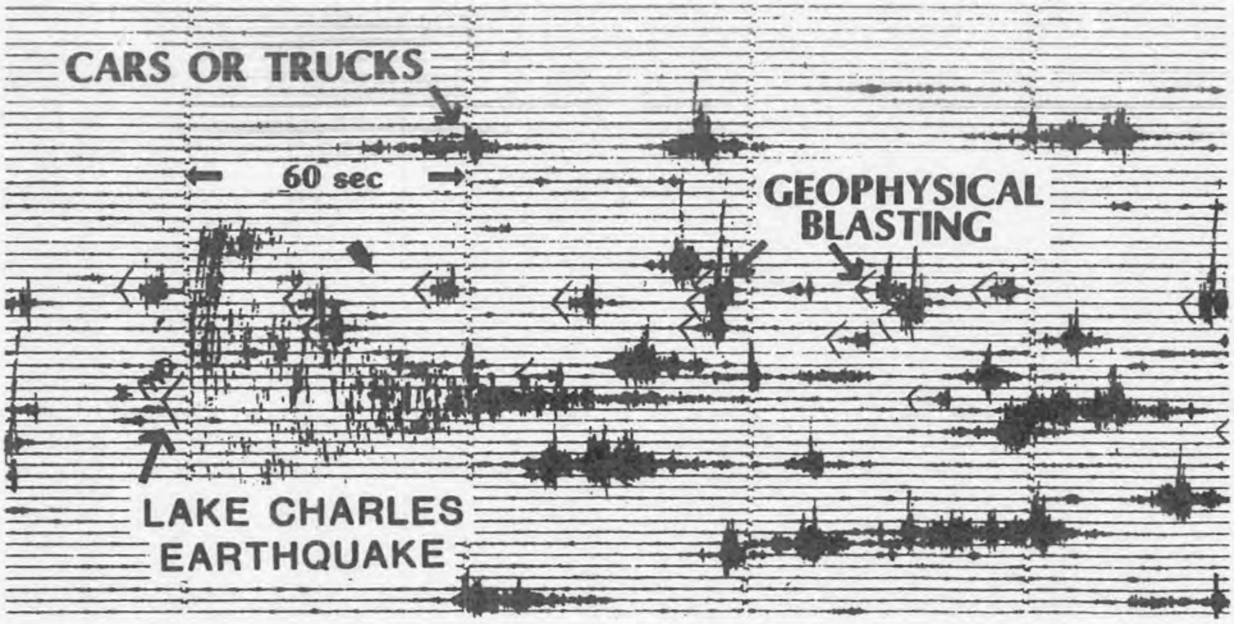

Figure 14. Sample seismogram showing records of geophysical blasting, vehicle movement and the Lake Charles earthquake of October 16, 1983.

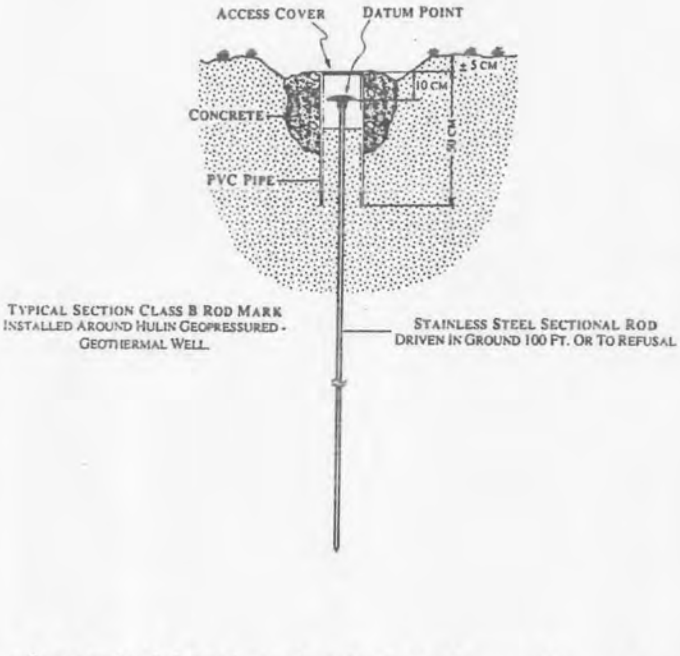

Figure 15. Illustration of a typical benchmark established near the geopressured-geothermal test well sites.

mine potential effects of brine contamination from spills and leaks in the production/injection system or storage facilities. Surface water and groundwater samples are analyzed quarterly for standard physical and chemical parameters indicative of freshwater contamination by brine. Surface water sampling stations are positioned down the hydrologic gradient, and groundwater observation wells are located in the most likely path of brine migration after subsurface injection, based on local groundwater flow directions. Water samples are analyzed for temperature, hardness, turbidity, pH, specific conductance (sc), dissolved oxygen ($O_2$), total organic carbon (C), ammonia ($NH_4$), sulfate ($SO_4$), chlorine (Cl), sodium (NA), potassium (K), magnesium (Mg), cadmium (Cd), manganese (Mn), calcium (Ca), chromium (Cr), barium (Ba), lead (Pb), arsenic (As), boron (B) and mercury (Hg). Except for mud contamination detected in the local surface water at the time of well drilling at Gladys McCall, the water quality monitoring program has not shown any evidence of brine contamination of the surface or groundwater.

## CONCLUSIONS

1. Well tests have demonstrated the feasibility of long-term, high-volume brine production from geopressured-geothermal sandstone reservoirs in the Gulf Coast basin.

2. Current technology can be used to recover gas from produced brine. However, the present economic situation of the oil and gas industry is not conducive to the commercialization of methane production from geopressured brines.

3. Methods have been developed and successfully tested to control calcium carbonate scale formation during long-term testing.

4. In predictive reservoir modeling, using the thickness of genetic sandstone reservoirs may lead to a better understanding of the longevity and production capability of a geopressured-geothermal sandstone reservoir.

5. High-volume, long-term brine production may cause fractures and/or faults within the genetic reservoir sand body, thereby producing pathways for fluid migration.

6. Techniques for reliable prediction of the life and ultimate productivity of geopressured-geothermal reservoirs are needed.

7. Environmental monitoring (continuous microseismic, subsidence, and water quality) of test sites before, during, and after well testing have shown no significant detrimental environmental effects from the long-term production and subsurface disposal of gas-separated brines into saline aquifers.

8. All presently known information is based on single well tests. Though the basic results may not change, the development of a geopressured-geothermal field with a large number of wells may modify these conclusions, especially with regard to environmental effects. Another yet untested concept is the possibility of using hot gas separated brines to aid secondary hydrocarbon recovery in depleted fields where deep wells penetrate geopressured-geothermal sandstones.

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