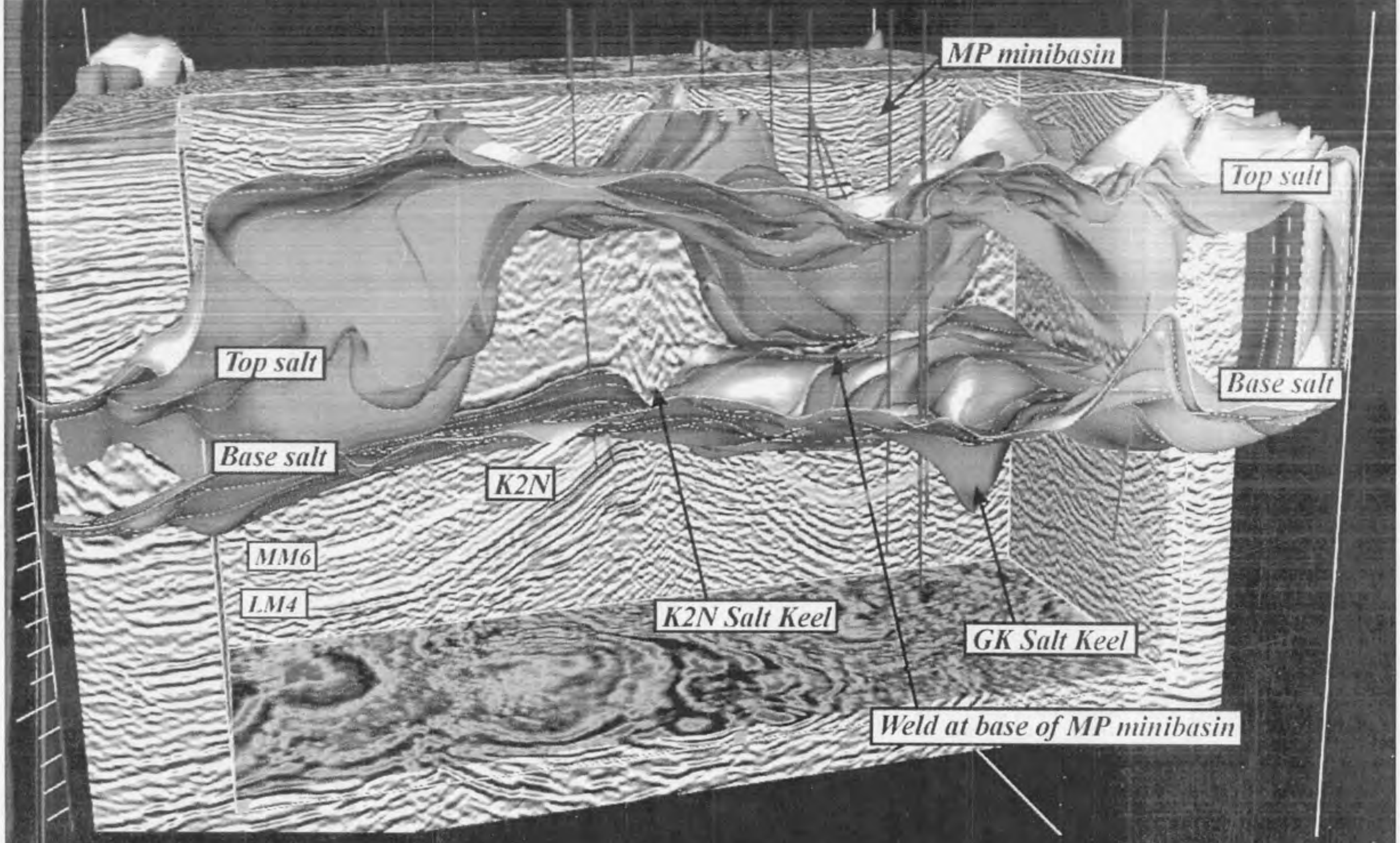
Gulf Coast Association of Geological Societies
and Gulf Coast Section SEPM



TRANSACTIONS
56th ANNUAL CONVENTION
LAFAYETTE, LOUISIANA
SEPTEMBER 25-27, 2006

Hosted by the Lafayette Geological Society

The Gulf Coast Geopressured-Geothermal Gas Resource: A Multipurpose, Environmentally Safe and Potentially Economic Reality in Today's Market?

Chacko J. John[1], Brian J. Harder[1], Reed J. Bourgeois[1], and Raymond Fortuna[2]

[1]Louisiana Geological Survey, Louisiana State University, 3079 Energy, Coast and Environment Bldg.,
Baton Rouge, LA 70803

[2]U.S. Department of Energy, Office of Geothermal Technologies, EE-2C, 1000 Independence Ave. SW,
Washington, D.C. 20585

EXTENDED ABSTRACT

The geopressured-geothermal resource consists of gas-saturated brines contained in sandstone reservoirs under higher than normal confining pressure and temperature. Such reservoirs are present in several sedimentary basins worldwide and those in the United States are shown in Figure 1. The northern Gulf of Mexico is the largest of such basins in the United States and is also one of the best known due mainly to the intensive exploration and production activities in this area. The northern Gulf of Mexico geopressured-geothermal resource has been estimated by Dorfman (1988) to contain approximately 250 TCF (trillion cubic ft) of recoverable natural gas and other researchers have provided various estimates ranging from 150 to 5,000 TCF and up to 11,000 quads of thermal energy in sandstone pore fluids to a depth of 22,500 ft. These estimates are all equivalent to many times more than the presently known conventional methane resources in the United States. The geopressured-geothermal resource contains chemical energy in the form of methane dissolved in pressurized brine, thermal energy consisting of high temperature brines (250°F) which could be used for secondary hydrocarbon recovery and/or electricity generation, and mechanical energy generated through high brine flow rates (20,000+ barrels per day) which could be utilized to drive turbines to generate electricity.

The U.S. Department of Energy conducted a geopressured-geothermal research program in the northern Gulf Coast to gather reliable geological engineering, environmental and economic information about this resource to determine its viability for development from 1975 to 1992. A comprehensive summary of the research program is provided in John *et al.* (1998). The research program involved industry, universities and national laboratories. The locations of all wells selected for testing are shown in Figure 2. Of these, four were drilled and tested (Nos. 7, 8, 9, and 15 shown in Figure 2) while all the others were donated by the oil and gas industry for testing. The Lafourche Crossing well location was originally selected but the well was not drilled. Some of the other wells (Nos. 10, 11, and 16 shown in Figure 2) were abandoned before testing due to well problems. Summary results of wells successfully tested are shown in Table 1. The Gladys McCall well located in Cameron Parish, Louisiana was tested for the longest period of time (4 yrs). Though eleven potential production zones were identified, only

---

John, C. J., B. J. Harder, R. J. Bourgeois, and R. Fortuna, 2006, The Gulf Coast geopressured-geothermal gas resource: A multipurpose, environmentally safe and potentially economic reality in today's market?: Gulf Coast Association of Geological Societies Transactions, v. 56, p. 303-307.

two zones were flow tested. During the test period the well produced over 27 million barrels of brine and 676 million SCF (standard cubic ft) of gas from the brine. Testing of Pleasant Bayou #2 well in Brazoria County, Texas, was significant in that a direct use application of the geopressured-geothermal resource was successfully demonstrated by the generation of electricity using a hybrid power electrical generation system which utilized the geothermal energy of heat and gas from the well fluids.

Plum *et al.* (1989) conducted an economic study of the geopressured-geothermal resource using characteristics of geopressured-geothermal brines found in the northern Gulf of Mexico. A computer model calculated breakeven prices necessary to market natural gas and electricity. The breakeven price was defined as the minimum per unit price for the developer to recover all direct and indirect costs plus a rate of return sufficient to compensate depreciation, the time value of money, and risk of failure. For a Gladys McCall-type production well with a constant flow rate of 25,000 barrels per day for 10 years, assuming all natural gas is sold and only the thermal energy is used to produce electricity, the breakeven prices calculated by Plum *et al.* (1989) were $7.70/MCF (thousand cubic ft) and $0.23/kWh (kilowatt-hrs) (1990 dollars). Inflated to 2005 dollars, the breakeven prices are $11.51/MCF and $0.34/kWh. (This inflation may not reflect actual cost increases in the oil & gas industry.) Major assumptions are: 1) a Gulf Coast oil or gas well can be taken over before its abandonment and converted into a geopressured-geothermal production well, 2) drilling of a shallow injection well, 3) a development and construction period of 18 months, and 4) a 15% discount rate. Using a different scenario of producing electricity from all energy resources (natural gas, heat, and hydraulic) yielded a breakeven price of $0.147/kWh (1990 dollars); inflated to 2005 dollars the breakeven price becomes $0.22/kWh. The Pleasant Bayou, Texas, resource characteristics gave similar breakeven prices. Plum *et al.* (1989) also modeled higher-quality geopressured-geothermal resources, *i.e.*, with higher temperatures and gas content. As could be expected, substantially lower breakeven prices were calculated.

The testing and development of a geopressured-geothermal resource necessitates high volume brine production (>20,000 barrels per day, per well) and the subsurface disposal of brine after gas extraction. The potential environmental issues of relevance

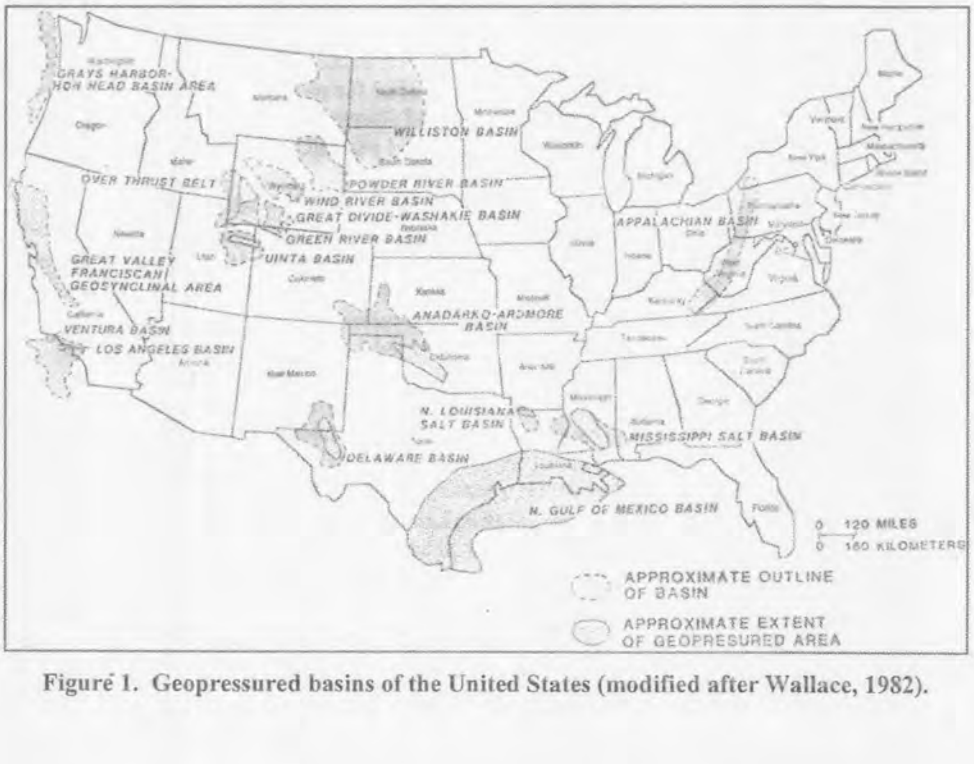


Figure 1. Geopressured basins of the United States (modified after Wallace, 1982).

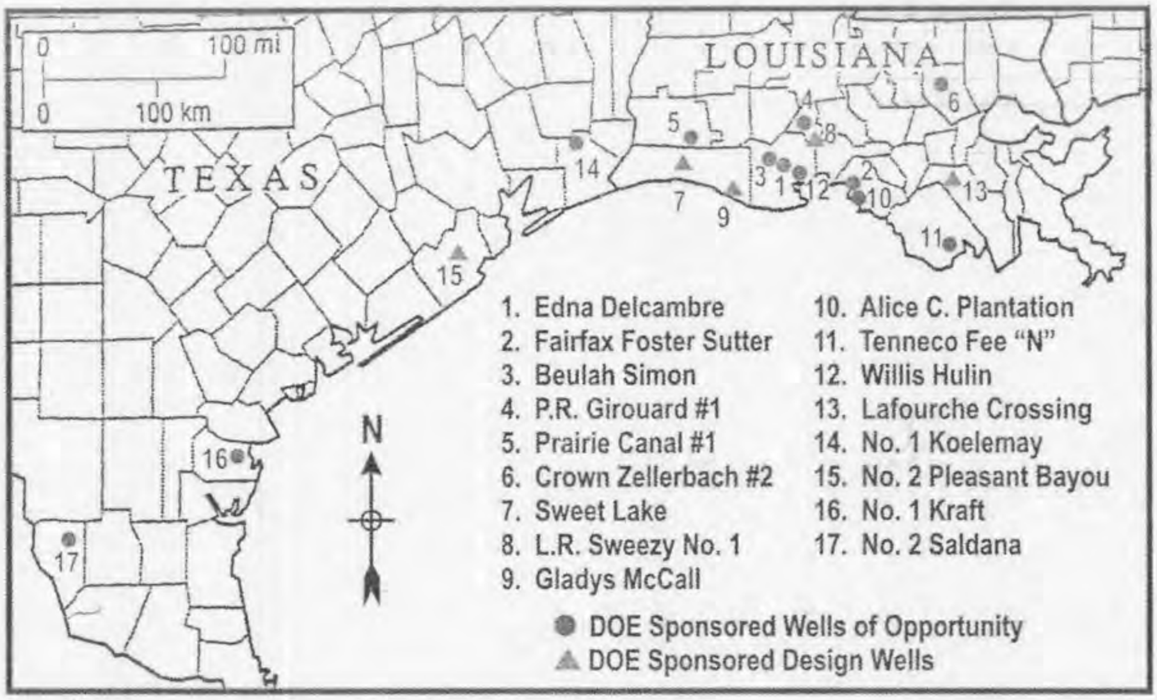


Figure 2. Location of wells selected for testing under the DOE geopressured-geothermal research program (courtesy of U.S. Department of Energy's Geothermal Program).

under this scenario include potential land surface subsidence, fault activation and/or reactivation, fresh-water aquifer contamination, and accidental brine spills. The geopressured-geothermal research program included monitoring programs designed to evaluate each of these environmental issues which were established prior to, during and after plugging and abandonment of the well. Microseismic monitoring, benchmark surveying, water sampling and analysis and monitoring of all surface activities were conducted. No noticeable or significant long-term detrimental environmental impacts were observed resulting from the well testing.

The program identified geopressured-geothermal fairways in Louisiana and Texas, determined that high brine flow rates (20,000-40,000 barrels per day) are possible for long periods of time without significant reservoir pressure drawdown, found that gas/brine ratio ranged from 24-55 SCF/STB (standard cubic ft of gas per stock-tank barrel) (Table 1) and found that used brine could be reinjected into sands below the freshwater aquifers without contamination. Inhibitors controlled corrosion and scaling, and a hybrid power system generated electricity using both separated methane and geothermal heat. In addition to generating electricity, there are a large number of the other potential applications of this resource as shown in Figure 3 and these other uses have not been tested. Profitable commercial development of this resource at that time was unfavorable. The energy picture today has changed and the gas and oil prices are considerably higher. With predicted worldwide shortages in a world dependent on fossil fuels, the costs are very likely to increase resulting from increasing consumption and demand for these resources. With the prevailing improved technology the development of the geopressured-geothermal resource in combination with its numerous direct and relatively environmentally safe uses will significantly lower the breakeven price for exploitation of this resource and could potentially be part of the answer to the country's energy problem. It is time for industry to reconsider the commercial viability of this unconventional alternative energy resource.

Table 1. Summary of test results from the geopressured-geothermal wells tested under the DOE program (John *et al.*, 1998).

Well Name	Depth (ft)	Pressure (psi)	Temp. (ºF)	Salinity (ppm TDS)	Gas/Brine Ratio (SCF/STB)	Flow Rate (BPD)	Methane (mol%)	CO2 (mol%)	Other Gases (mol%)	Porosity (%)	Permeability (mD)
Delcambre 3sd	12,869	11,012	238	133,300	24.0	10,333	92.8	1.1	6.1	26.0	44.0
Delcambre 1sd	12,573	10,858	234	113,000	24.0	12,653	95.4	2.0	2.6	29.0	364.0
F.F. Sutter	15,781	12,220	270	190,904	24.9	7,747	89.6	7.9	2.5	19.3	14.3
Buelah Simon	14,722	13,015	266	103,925	24.0	11,000	88.9	7.7	3.4	17.4	11.6
P.R. Giroud	14,744	13,203	274	23,500	44.5	15,000	91.3	6.0	2.7	26.0	220.0
P. Canal	14,976	12,942	294	43,400	47.0	7,100	88.4	8.4	3.2	22.5	90.0
C. Zellerbach	16,720	10,144	330	31,700	55.7	3,887	71.0	23.5	5.5	17.0	14.1
Amoco Fee-Sweet Lake A	15,387	11,974	298	160,000	34.0	34,000	88.7	8.6	2.6	20.0	400.0
Parcperdue - L.R. Sweezy No. 1	13,395	11,410	237	99,700	30.0	10,000	94.0	2.5	3.5	29.4	500.0
Gladys McCall A	15,508	12,936	298	95,500	30.4	36,500	86.9	9.5	3.6	24.0	90.0
Gladys McCall B	15,158	12,821	288	94,000	30.4	36,000	85.9	10.6	3.5	22.0	130.0
Pleasant Bayou Well No. 2	16,465	9,800	302	127,000	24.0	25,000	85.0	10.0	5.0	19.0	200.0
Hulin No. 1	21,546	18,500	360	195,000	34.0	15,000	93.0	4.0	3.0	-	13.0
Riddle Saldana No. 2	9,745	6,627	300	12,800	41.0	1,950	75.0	21.4	3.75	20.0	7.0
Lear Koelemay No. 1	11,590	9,450	260	15,000	35.0	3,200	81.4	13.4	5.2	26.0	85.0
Ross Draft No. 1	12,750	10,986	263	23,000	45.0	-	-	-	-	23.0	39.0

REFERENCES CITED

Dorfman, M. H., 1988, Geopressured-geothermal energy and associated natural gas: Proceedings, Geothermal Energy Symposium, 11th Annual Energy-Source Technology Conference and Exhibit, American Society of Mechanical Engineers, Geothermal Resources Council, p. 97-101.

John, C. J., G. Maciaz and B. J. Harder, 1998, Gulf Coast geopressured-geothermal program summary report compilation: DOE Contract No. DE-FG07-95ID 13366 Final Report v. I-IV.

Negus-deWys, J., and M. H. Dorfman, 1990, The geopressured-geothermal resource: Transition to commercialization: Proceedings, Industrial Consortium for the Utilization of the Geopressured-Geothermal Resource, EG&G Idaho, Inc., Idaho National Engineering Laboratory, Idaho Falls, p. 9-17.

Plum, M. M., J. Negus-deWys, D. David and B. C. Lunis, 1989, Economic review of the geopressured-geothermal resource with recommendations: EG&G Idaho, Inc., Report #2581, Idaho National Engineering Laboratory, Idaho Falls.

Wallace, R. H., ed., 1982, Geopressured-geothermal energy resource appraisal: Hydrogeology and well testing determine producubility: Louisiana Geological Survey Guidebook Series No.2, 112 p.

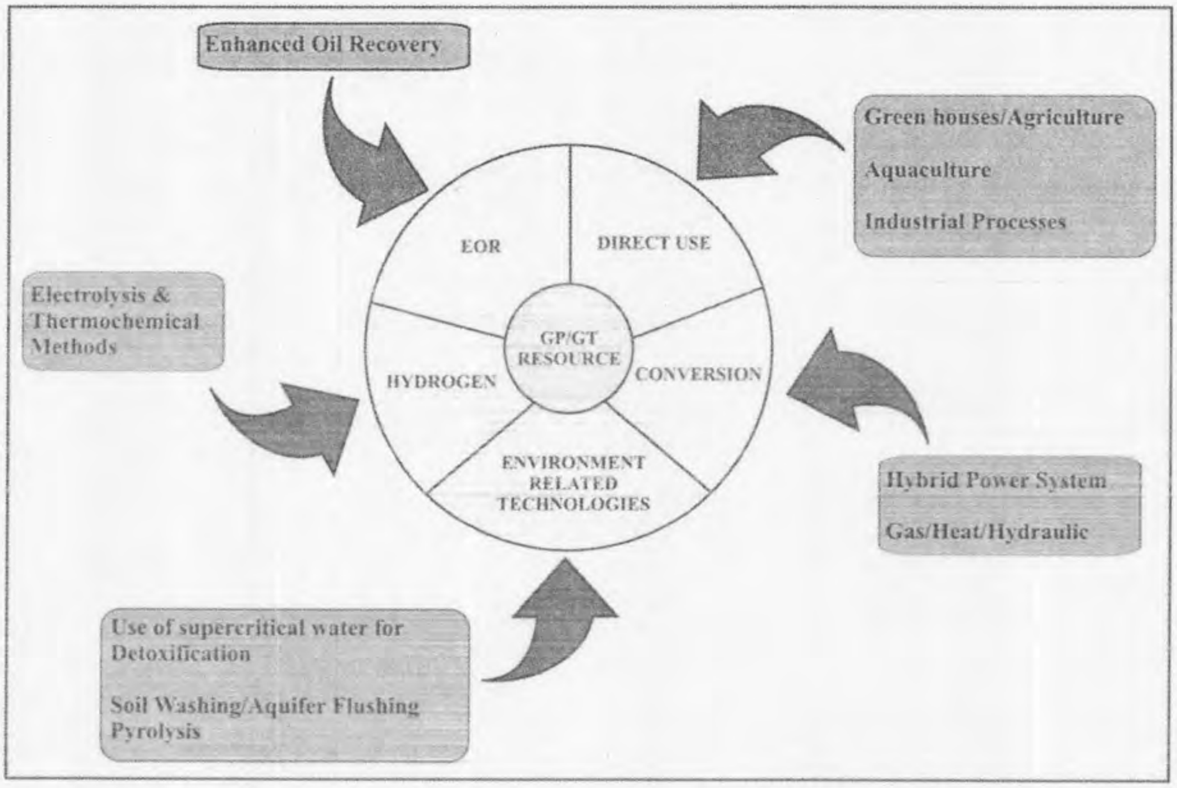


Figure 3. Potential applications of the geopressured-geothermal resource (modified after Negus-deWys and Dorfman, 1990).