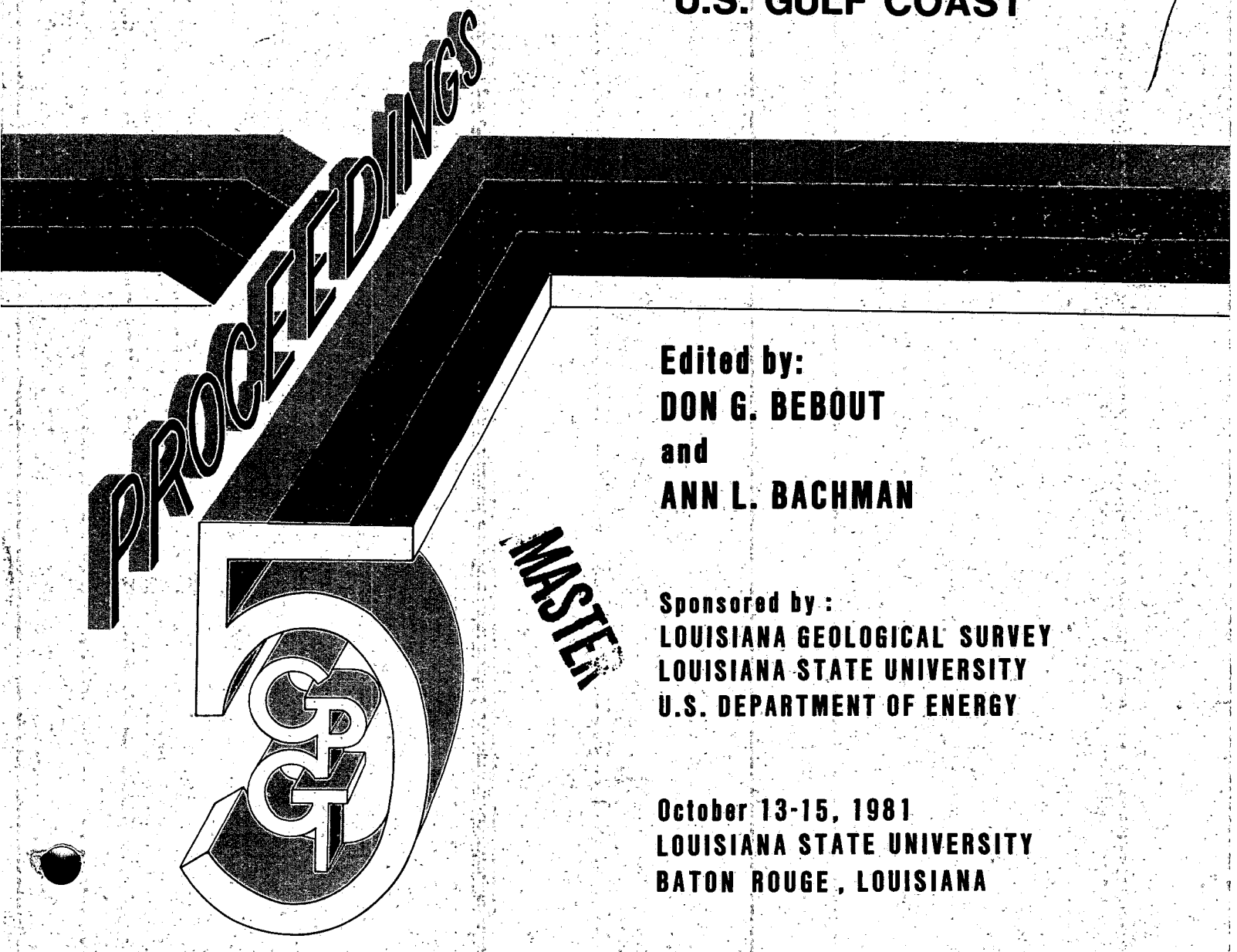
CONF-811026-57

FIFTH CONFERENCE

GEOPRESSURED - GEOTHERMAL ENERGY

U.S. GULF COAST



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GEOLOGY OF THE CIBICIDES JEFFERSONENSIS SANDSTONE, PARCPERDUE AREA, LOUISIANA

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ABSTRACT

The DOW-DOE No. 1 Leroy Sweezy geopressured test well was drilled to a depth of 13,600 feet in Parcperdue Field, near Lafayette. The object Cibicides Jeffersonensis reservoir is isolated vertically by shale and limited laterally by well defined faulting. The limited size of the reservoir will allow significant pressure depletion over a production period of several months.

The Cibicides Jeffersonensis represents a barrier bar environment of deposition and the bounding shales are of marine origin. The sand is highly porous, permeable and relatively unconsolidated.

The sand and underlying shale interval were logged and cored. Core studies include lithological description, rock mechanical properties, porosity and permeability, sieve analysis, thin-section petrography, scanning-electron micrography and organic geochemistry of the shale.

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DISCLAIMER

GEOLOGY OF THE CIB JEFF GEOPRESSURED SAND

PARCPERDUE FIELD, LOUISIANA

by

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DOW CHEMICAL U S A
SEPTEMBER, 1981

ABSTRACT

The DOW-DOE No. 1 Leroy Sweezy geopressured test well was drilled to a depth of 13,600 feet in Parc Perdue Field, near Lafayette. The objective Cib jeff sand reservoir is isolated vertically by shale and limited laterally by well defined faulting. The limited size of the reservoir will allow significant pressure depletion over a production period of several months.

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The sand and underlying shale interval were logged and cored. Core studies include lithologic description, rock mechanical properties, porosity and permeability, sieve analysis, thin-section petrography, scanning-electron micrography and organic geochemistry of the shale.

REGIONAL GEOLOGIC SETTING

The Gulf Coast geosyncline extends from Alabama to northern Mexico and covers an area greater than 250,000 square miles. Cenozoic clastic sediments fill the basin and attain a maximum thickness of greater than 50,000 feet in southern and offshore Louisiana, east of the Sabine arch.

Sedimentation patterns are influenced by differential rates of sediment influx, changing sea levels, deeply burried salt structures and salt tectonics, and down-to-the coast contemporaneous faulting. Dip is generally southeastward and is modified by a series of younger basinward flexures which exhibit great thickining of sedimentary units on the downdip sides, generally reflecting the effect of contemporaneous faulting.

A major marine transgression occurred during the upper Oligocene epoch. The massive Anahuac shale was deposited at this time on the continental shelf. The proto-Mississippi embayment was located in the area of south-central Louisiana during Frio-Vicksburg time (upper Oligocene), which further influenced the marine character of the sediments. Minor regressive episodes caused the formation on the continental shelf of shoals, barrier bars, and possibly barrier islands. Many of these barrier bars are now targets of oil and gas exploration. They are typically isolated sand bodies in an interval of massive shale and exhibit a coarsening-upward log character. In south Louisiana, such sands are usually identified by a characteristic foram. The objective sand, of the upper Frio formation, is identified by the foraminifera Cibicides jeffersonensis, henceforth referred to as Cib jeff.

GEOLOGY OF THE PARCPERDUE AREA

The geopressured zone at Parcperdue occurs in sediments of Upper and Middle Oligocene age, principally in the Frio formation. The top of the formation is picked at the first occurrence of the foram Discorbis gravelli, which occurs in the abandoned well, the Phillips No. 1-A Sweezy, at a depth of approximately 12,700'. Cross-section B-B', Figure 2, illustrates the palentologic sequence in the area. Figure 1 is the location map.

Production in the field is principally from the Cib jeff and Camerina zones. Camerina is the deepest zone pentrated. The area is traversed by a number of faults which intersect to form discrete blocks. Traps are structural and (gas)

production is from closures within fault blocks or against faults. The objective Cib jeff sand is in a fault block bounded by faults "A", "B", and "C" as shown on the structure map, Figure .

GEOLOGY OF THE CIB JEFF SAND

The sand occurs at a depth of 13,340 feet and is approximately 80 feet thick. The Cib jeff sand represents an offshore barrier bar environment of deposition. Such deposits are elongated and lenticular in form and may vary in size from a few square miles to several hundred square miles. The Cib jeff sand in the Parcperdue area is conservatively estimated to have an areal extent of about ten square miles. The areal extent of the Cib jeff reservoir within the fault block is approximately 1.5 square miles (See Fig. 3 and 4).

Geologic control on the fault block is excellent. Fault cuts can be picked or inferred in eight wells located near Faults A, B and C, as shown on the Cib jeff structure map, Figure 3 . The area is traversed by seven CDP seismic lines which intersect the test fault block at eleven points. The total of nineteen control points affords very accurate mapping of the fault block dimensions, essential in making reservoir calculations. The total area of the fault block has been determined to be 939 acres.

The Cib jeff sand is overlain by approximately 1,300 feet of marine shale and underlain by approximately 3,000 feet of shale. The bounding faults, which range in throw from 150 feet to over 500 feet will provide an excellent seal against the shale and isolate the Cib jeff reservoir.

The Cib jeff sand is continuous and realtively consistent in thickness over the test fault block, as illustrated on the isopach map, Figure 4 .

Assuming an average thickness of 50 feet, reservoir pore volume is 1.06×10^8 bbl (939 ac x 43,560 ft^2/ac x 50' x 29% Ø x 0.178 bbl/ft^3). If the well produces at a rate of 20,000 bpd for a 270 day period, the total water produced will be 5.4×10^6 bbl. This production represents five percent depletion ($5.4 \times 10^6 / 1.06 \times 10^8 \times 100$) of the reservoir.

The Cib jeff sand reservoir is ideally suited for a test of the geopressured geothermal concept. The reservoir is exceptionally well defined, is consistent

within the fault block, is sealed on all sides, and possesses good porosity and permeability. The smallness of the reservoir will afford a significant pressure depletion over a relatively short period of production, thus providing detailed information on the production characteristics of a geopressured reservoir.

TEST WELL GEOLOGY

The Dow-DOE No. 1 Sweezy (original hole) was drilled to a T.D. of 13,600' and logged on April 12, 1981. Shallower formations (principally Miocene) are continental-fluvial in nature. Transition to a more marine facies occurs at a depth of approximately 11,800'. Below that depth, the entire section is shale with the exception of three sands, each 100' or less in thickness, occurring at depth of 11,920', 12,305', and the objective Cib jeff sand at 13,341'.

Paleontology was done by George N. May and Associates of Lafayette. A summary of their report is given in Table 1 .

TABLE 1
SUMMARY OF PALEONTOLOGY

SAMPLE RANGE 11500'	13600'
IN SIPHONINA DAVISI	11500'
CRISTELLARIA 47	11900'
NODOSARIA VERTEBRALIS	12170'
DISCORBIS GRAVELLI	12780'
HET SP. (VERY RARE)	12880'
CIBICIDES JEFFERSONENSIS	13140'
BOLIVINA PERCA	13490'

NO FURTHER DIAGNOSTIC FOSSILS WERE ENCOUNTERED.

Well logs run in the open hole include Dual induction-SFL-sonic, Neutron-Formation density-Gamma ray, Dipmeter, Saraband, Mechanical properties, Temperature log, and Directional survey. The DIL-SFL-Sonic log of the Cib jeff sand interval is shown in Figure 5 .

Calculated porosity of the massive sand is 30% which is in good agreement with measured values. Salinity calculations from SP are considered unreliable due to variations in the method used. Several calculations were made using the conventional method, the method of Dunlap and Dorfman, and the Rwa method, on both the original hole and the first side-track. Values range from 50,000 ppm to 120,000 ppm, with the best estimate 95,000 to 100,000 ppm.

CORE EVALUATION

Two 60' x 4" conventional cores were taken from a depth of 13,340' to 13,460'. Recovery was 100%. The upper core cut just above the top of the sand and the second core cut approximately 45' of shale below the sand. The sandstone was clean, well sorted, and very friable to unconsolodated. The lower 20' was more consolodated, finer grained, and less porous and permeable. Core evaluation can be subdivided into four parts:

A. Conventional porosity and permeability measurements performed by Corelab. Average porosity was 28% and average permeability was 3700 md. Results are presented in Table 2 .

   A summary of all Cib jeff sand characteristics is given in Table 3.

TABLE 2

PERMEABILITY AND POROSITY ANALYSIS

Sample #	Depth	Permeability Millidarcys	Porosity %	Description
2	13342.5	260	25.9	SD VF-FG SHY
3	13343.2	810	22.2	SD FG SSLTY
4	13344.5	4550	26.4	SD FG CLN
5	13346.5	4370	29.7	SD FG CLN
6	13348.5	4780	29.2	SD FG CLN
7	13350.0	4740	30.1	SD FG CLN
8	13352.7	5160	27.8	SD FG CLN
9	13355.5	7780	29.6	SD FG CLN
10	13357.6	6580	29.3	SD FG CLN
11	13360.5	3650	28.1	SD FG CLN
12	13362.2	2590	27.8	SD FG CLN
13	13364.0	1420	27.8	SD FG CLN SSLTY
14	13365.5	2300	27.4	SD FG CLN
15	13367.5	5350	28.6	SD FG CLN
16	13368.5	27	22.7	SD VGD SSHY SLIG (L) SSL
17	13369.5	825	29.4	SD FG SSLTY
18	13370.5	7620	30.5	SD FG CLN
19	13372.5	4920	30.4	SD FG CLN
20	13375.5	2930	29.1	SD FG SSLTY
23	13390.0	205	28.4	SD VFG SLTY
24	13394.5	410	31.5	SD VFG SLTY
27	13397.5	1260	29.2	SD VF-FG SSLTY
28	13400.0	.06	14.8	SD VFG SSHY SLTY
29	13401.0	.36	14.4	SD VFG VSSHY VSLTY
30	13402.0	46	23.3	SD VFG SLTY
32	13405.0	15	21.2	SD VFG VSLTY
33	13406.0	265	25.2	SD VF-FG SSLTY-SLTY
36	13409.0	.26	18.6	SD VFG VSLTY
46	13419.0	0	10.2	SD VFG VSLTY VCALC
61	13438.0	.63	13.1	SD VFG SHY (L) VSLTY
71	13450.0	.35	12.2	SD VFG SS-SHY (L) VSLTY
78	13404.0	1.1	20.9	SD VFG VSLTY

TABLE 3

CIB JEFF SAND

SUMMARY OF CHARACTERISTICS

Depth:	13,341'
Gross Thickness	73'
Net Thickness	59'
Average Ø	29%
Corrected Ø	26%
Average Perm	3,700
Corrected Perm	2,239 md
Temp.	220°F
RWA	.025
Salinity: (RWA)	110,000 ppm

B. Lithologic description and mechanical properties performed by Terra Tek, Inc. Terra Tek is also responsible for core preparation, handling, distribution and shipping.

Mechanical testing at in-situ conditions will provide data to determine parameters for reservoir testing and reservoir performance prediction and will identify potential problems associated with reservoir production and evaluation. The test matrix is shown in Table 4 .

TABLE 4

TEST MATRIX

Type	Number	Porosity	Compressibility	Young's Modulus	Poisson's Ratio	Compaction Coefficient	Pore Volume Change	Permeability	Resistivity	Ultrasonic Velocities	Strength	Creep Strain
Quick-Response	2	2	2	2	2	2	2	4	--	--	--	--
Compaction	5	5	5	5	5	5	5	10	--	6	--	--
Triaxial	3	3	3	3	3	--	3	6	--	--	3	--
Creep	3	3	3	3	3	3	3	3	--	--	--	3
Resistivity	1	1	--	--	--	--	--	--	1	--	--	--
Total	14	14	13	13	13	10	13	23	1		3	3

C. Sieve Analysis, Acid solubility, clay analysis, scanning election micrography and thin section petrographic evaluation to be performed by Dowell and Dow Chemical.

D. Sourcerock Analysis of shale samples performed by Geochem Laboratories, Houston.

Organic geochemistry of three samples indicate that organic content is low, thermal maturity is low, little hydrocarbon other than biogenic gas has been generated, and, hence, sourcerock potential is poor. A summary of organic geochemical data is given in Table 5.

TABLE 5

SHALE SOURCE ROCK CHARACTERISTICS
DOW-DOE NO. 1 SWEEZY

	SAMPLE NO.		
	1	2	3
DEPTH			
Total organic carbon	0.24	0.24	0.27
Extract Bitumen ppm	46		27
Free HC mg/g	0.13	0.04	0.11
HC Potential mg/g	0.26	0.07	0.11
% Paraffin	36.0		39.5
% Aromatic	63.6		59.8
% Isoprenoid	0.4		0.7
Pristane/Phytane	0.67		1.33
C.P.I.	1.29		1.70
Vitranite Reflect %	0.41		0.40
Maturation Index	1+		1+

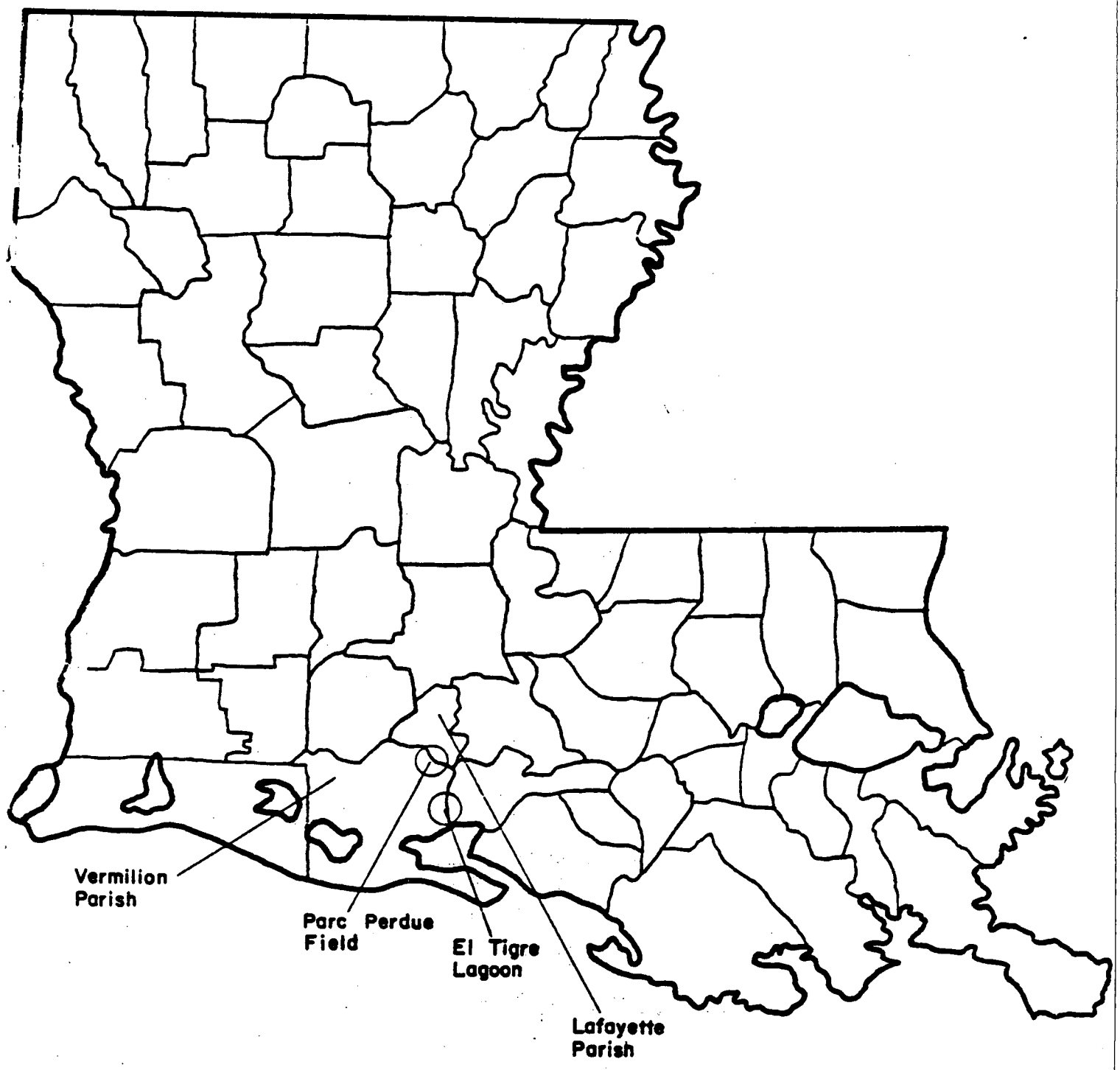


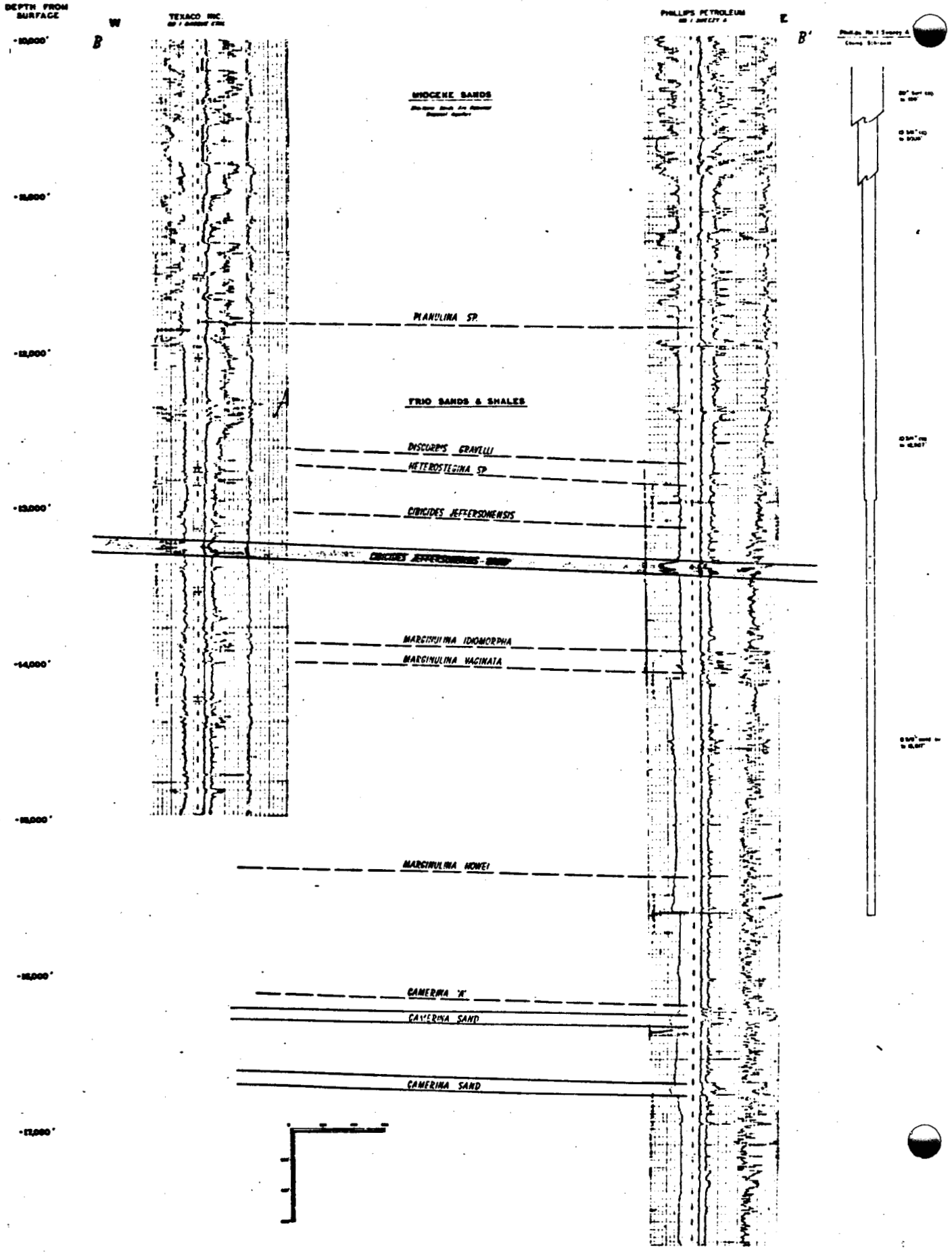
Figure 1. State of Louisiana: Location Map

Scale: 1" = Approximately 40 Miles

FIGURE 1

FIGURE 2

PARC PERDUE GEOPRESSURED GEOTHERMAL PROSPECT
VERMILLION PARISH, LOUISIANA



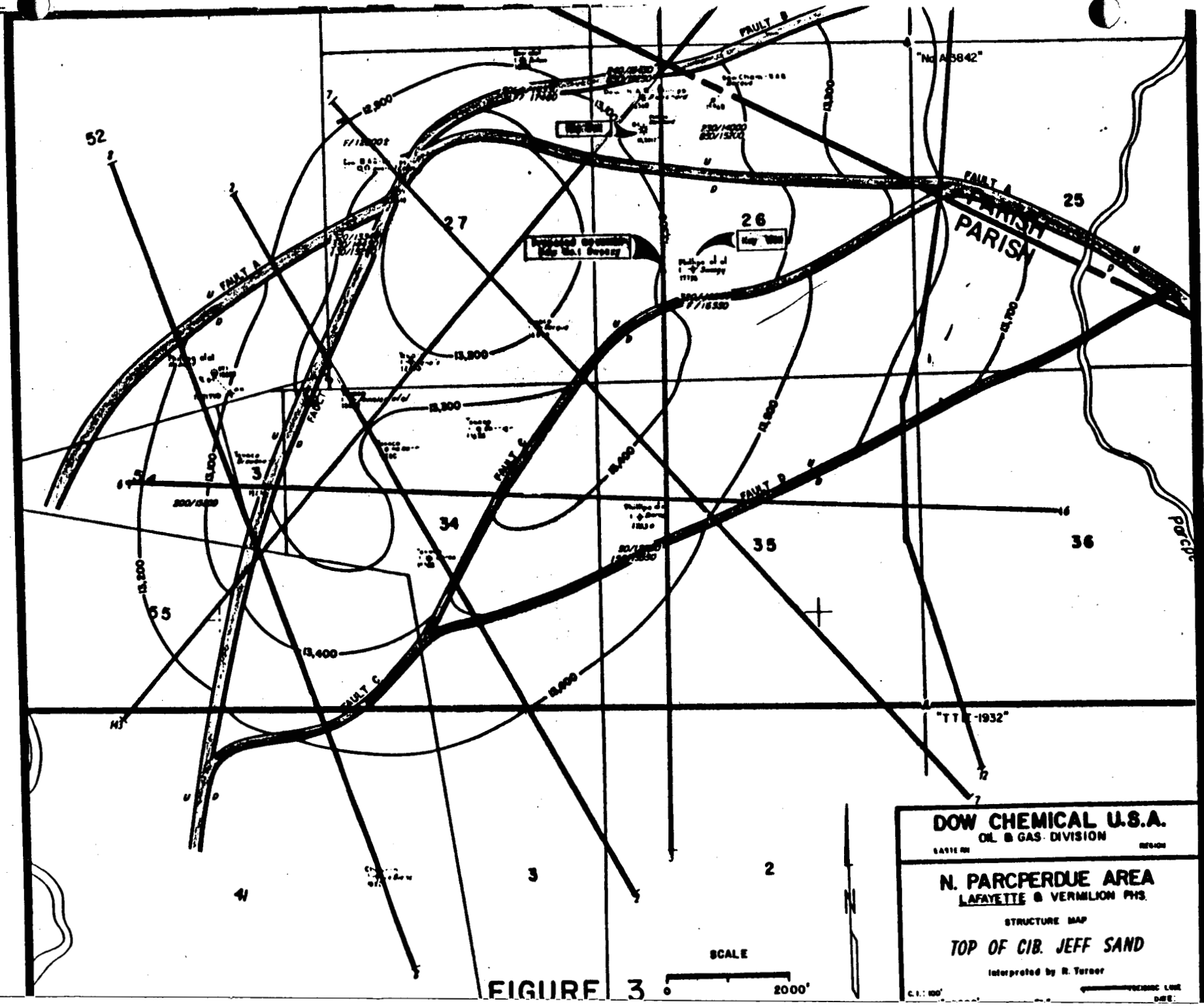

FAULT B
FAULT A
FAULT C
PARISH
"No. A-3842"
"T T L -1932"
52
27
26
25
3
34
35
36
55
41
2
13,300
13,400
13,500
SCALE
0
2000'
DOW CHEMICAL U.S.A.
OIL & GAS DIVISION
N. PARCPERDUE AREA
LAFAYETTE & VERMILION PHS.
STRUCTURE MAP
TOP OF CIB. JEFF SAND
Interpreted by R. Turner

FIGURE 3

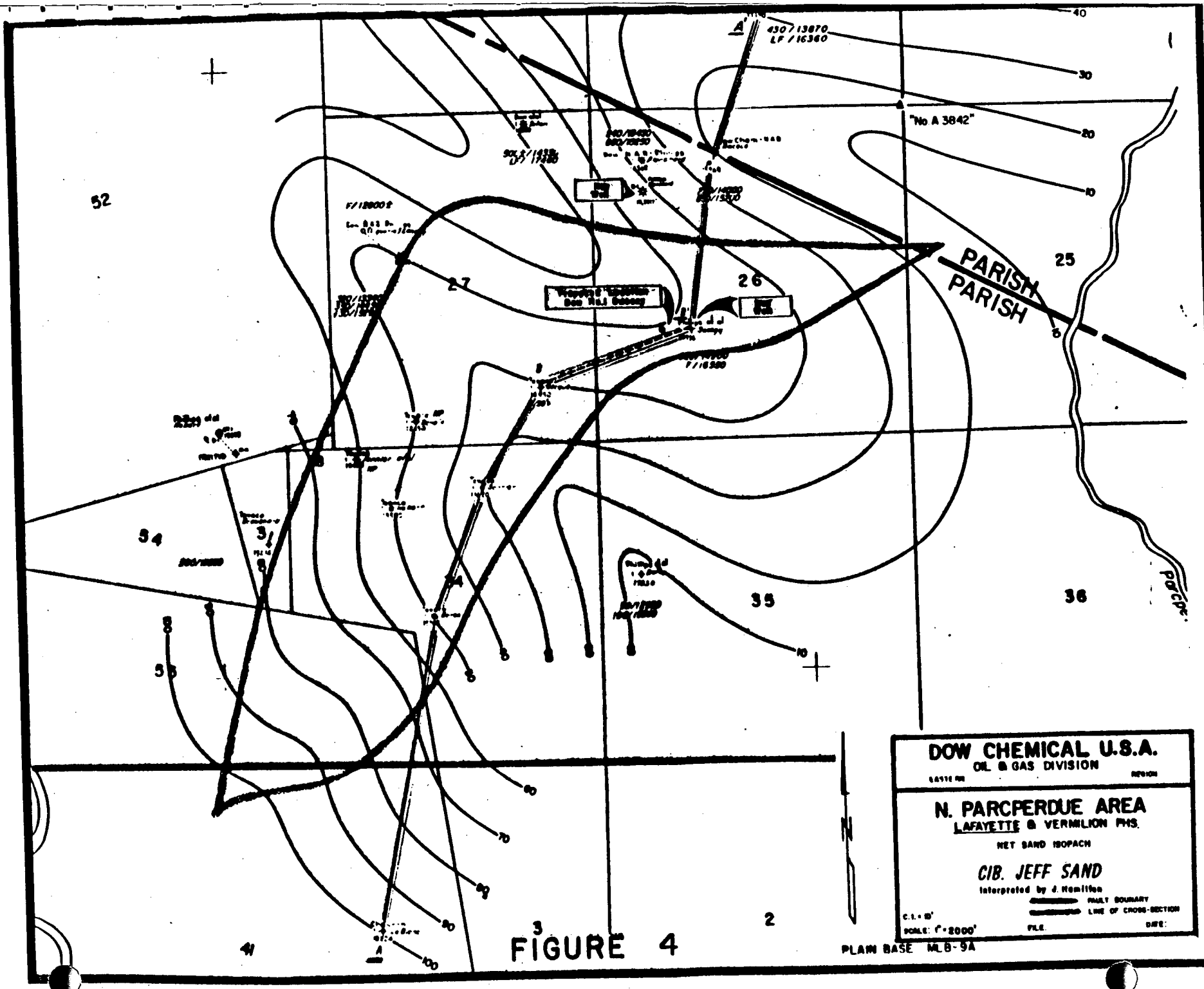


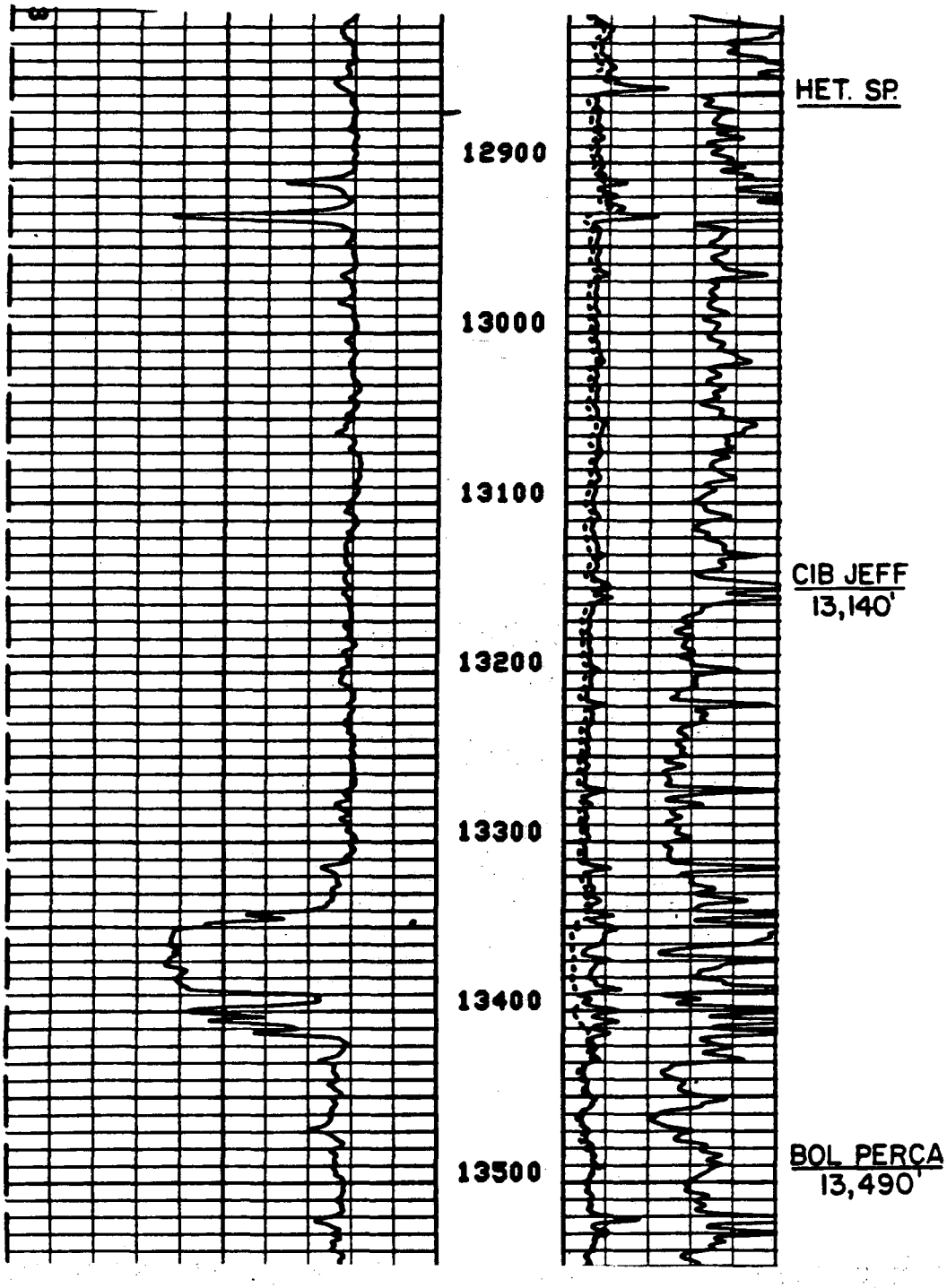
FIGURE 4

PLAN BASE ML8-9A

FIGURE 5

DIL - SFL LOG

DOW - DOE NO. 1 SWEEZY



MARINE ENVIRONMENT ZONE III - INNER SHELF