

# OILFIELD RESEARCH LABORATORIES

536 NORTH HIGHLAND - CHANUTE, KANSAS 66720 - PHONE (316) 431-2650

October 27, 1980

L & L Oil Company  
P.O. Box 13  
Benedict, Kansas 66741

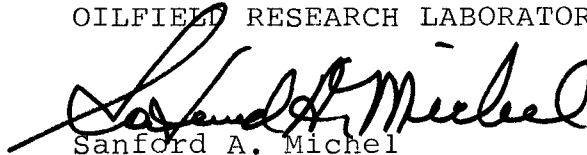
Gentlemen:

Enclosed herewith is the analysis of the rotary core taken from the Brodbeck Lease, Well No. 13, Crawford County, Kansas, and submitted to our laboratory on September 30, 1980.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES



Sanford A. Michel

SAM/tem

5 c to Benedict, Kansas

# Oilfield Research Laboratories

## GENERAL INFORMATION & SUMMARY

Company L. & L. Oil Company Lease Brodbeck Well No. 13

Location -

Section 4 Twp. 28S Rge. 22E County Crawford State Kansas

Elevation, Feet - - - - -

Name of Sand - - - - - Tucker

Top of Core - - - - - 592.0

Bottom of Core - - - - - 606.6

Top of Sand - - - - - 592.0

Bottom of Sand - - - - - 606.6

Total Feet of Permeable Sand - - - - - 13.0

Total Feet of Floodable Sand - - - - - 4.6

Distribution of Permeable Sand:  
Permeability Range  
Millidarcys

Feet

Cum. Ft.

0 - 5

6.4

6.4

5 - 10

4.0

10.4

20 - 30

1.0

11.4

150 - 200

1.6

13.0

Average Permeability Millidarcys - - - - - 27.4

Average Percent Porosity - - - - - 15.1

Average Percent Oil Saturation - - - - - 39.1

Average Percent Water Saturation - - - - - 44.2

Average Oil Content, Bbls./A. Ft. - - - - - 469.

Total Oil Content, Bbls./Acre - - - - - 6,846.

Average Percent Oil Recovery by Laboratory Flooding Tests - - - - - 12.9

Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft. - - - - - 181.

Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre - - - - - 832.

Total Calculated Oil Recovery, Bbls./Acre - - - - - See "Calculated Recovery" Section.

-2-

The core was sampled and the samples sealed in plastic bags by a representative of the client. Fresh water mud was used as a drilling fluid. The core was reported to be from a virgin area.

#### FORMATION CORED

The detailed log of the formation cored is as follows:

| <u>Depth Interval,<br/>Feet</u> | <u>Description</u>                                                      |
|---------------------------------|-------------------------------------------------------------------------|
| 592.0 - 593.0                   | Light brown and gray shaly sandstone.                                   |
| 593.0 - 595.6                   | Dark brown slightly calcareous sandstone.                               |
| 595.6 - 606.6                   | Light brown and gray laminated slightly calcareous sandstone and shale. |

#### LABORATORY FLOODING TESTS

The sand in this core responded to laboratory flooding tests, as a total recovery of 832 barrels of oil per acre was obtained from 4.6 feet of sand. The weighted average percent oil saturation was reduced from 46.1 to 33.2, or represents an average recovery of 12.9 percent. The weighted average effective permeability of the samples is 5.39 millidarcys, while the average initial fluid production pressure is 29.0 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 15 samples tested, 5 produced water and oil, and 1 sample produced water only. This indicates that approximately 33 percent of the sand represented by these samples is floodable pay sand.

CALCULATED RECOVERY

It would appear from a study of the core data, that efficient primary and waterflooding operations in the vicinity of this well should recover approximately 1,340 barrels of oil per acre. This is an average recovery of 292 barrels per acre foot from 4.6 feet of floodable sand analyzed in this core.

These recovery values were calculated using the following data and assumptions:

|                                                |      |
|------------------------------------------------|------|
| Original formation volume factor, estimated    | 1.04 |
| Reservoir water saturation, percent, estimated | 20.0 |
| Average porosity, percent                      | 17.2 |
| Oil saturation after flooding, percent         | 33.2 |
| Performance factor, percent, estimated         | 50.0 |
| Net floodable sand, feet                       | 4.6  |

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## RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company L. & L. Oil Company Lease Brodbeck Well No. 13

| Sample No. | Depth, Feet | Effective Porosity Percent | Percent Saturation |       |       | Oil Content Bbls. / A Ft. | Perm., Mill. | Feet of Sand |          | Total Oil Content | Perm. Capacity Ft. X md. |
|------------|-------------|----------------------------|--------------------|-------|-------|---------------------------|--------------|--------------|----------|-------------------|--------------------------|
|            |             |                            | Oil                | Water | Total |                           |              | Ft.          | Cum. Ft. |                   |                          |
| 1          | 592.5       | 15.9                       | 43                 | 39    | 82    | 530                       | 4.8          | 1.0          | 1.0      | 530               | 4.80                     |
| 2          | 593.5       | 15.7                       | 39                 | 41    | 80    | 475                       | 27.          | 1.0          | 2.0      | 475               | 27.00                    |
| 3          | 594.5       | 16.3                       | 40                 | 46    | 86    | 506                       | 169.         | 1.0          | 3.0      | 506               | 169.00                   |
| 4          | 595.5       | 20.2                       | 58                 | 21    | 79    | 909                       | 199.         | 0.6          | 3.6      | 545               | 119.40                   |
| 5          | 596.5       | 15.1                       | 34                 | 47    | 81    | 398                       | 0.43         | 1.4          | 5.0      | 557               | 0.60                     |
| 6          | 597.5       | 14.4                       | 36                 | 49    | 85    | 402                       | 2.5          | 1.0          | 6.0      | 402               | 2.50                     |
| 7          | 598.5       | 11.1                       | 30                 | 65    | 95    | 258                       | 1.2          | 1.0          | 7.0      | 258               | 1.20                     |
| 8          | 599.5       | 18.8                       | 57                 | 18    | 75    | 831                       | 7.8          | 1.0          | 8.0      | 831               | 7.80                     |
| 9          | 600.5       | 15.9                       | 41                 | 44    | 85    | 505                       | 10.          | 1.0          | 9.0      | 505               | 10.00                    |
| 10         | 601.5       | 16.9                       | 47                 | 32    | 79    | 616                       | 5.5          | 1.0          | 10.0     | 616               | 5.50                     |
| 11         | 602.5       | 15.1                       | 37                 | 48    | 85    | 433                       | 6.5          | 1.0          | 11.0     | 433               | 6.50                     |
| 12         | 603.5       | 14.8                       | 16                 | 62    | 78    | 184                       | 0.84         | 1.0          | 12.0     | 184               | 0.84                     |
| 13         | 604.5       | 13.8                       | 60                 | 14    | 74    | 642                       | Imp.         | 1.0          | 13.0     | 642               | 0.00                     |
| 14         | 605.5       | 11.3                       | 33                 | 61    | 94    | 289                       | 0.48         | 1.0          | 14.0     | 289               | 0.48                     |
| 15         | 606.5       | 10.5                       | 15                 | 79    | 94    | 122                       | Imp.         | 0.6          | 14.6     | 73                | 0.00                     |

Oilfield Research Laboratories

SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

| Company | L & L Oil Company       |                          | Lease                    | Brodbeck                                |                                       | Well No.13 |  |
|---------|-------------------------|--------------------------|--------------------------|-----------------------------------------|---------------------------------------|------------|--|
|         | Depth Interval,<br>Feet | Feet of Core<br>Analyzed | Feet of Core<br>Analyzed | Average<br>Permeability,<br>Millidarcys | Permeability<br>Capacity<br>Ft. x Md. |            |  |
|         | 592.0 - 606.6           |                          | 13.0                     | 27.4                                    | 355.62                                |            |  |
|         |                         |                          |                          |                                         |                                       |            |  |
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# Oilfield Research Laboratories

## RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company L & L Oil Company Lease Brodbeck Well No. 13

| Sample No. | Depth, Feet | Effective Porosity Percent | Original Oil Saturation |              | Oil Recovery |              | Residual Saturation |         |              | Volume of Water Recovered cc* | Effective Permeability Millidarcys** | Initial Fluid Production Pressure Lbs./Sq./In. |
|------------|-------------|----------------------------|-------------------------|--------------|--------------|--------------|---------------------|---------|--------------|-------------------------------|--------------------------------------|------------------------------------------------|
|            |             |                            | %                       | Bbls./A. Ft. | %            | Bbls./A. Ft. | % Oil               | % Water | Bbls./A. Ft. |                               |                                      |                                                |
| 1          | 592.5       | 16.0                       | 43                      | 534          | 0            | 0            | 43                  | 40      | 534          | 0                             | Imp.                                 | -                                              |
| 2          | 593.5       | 15.6                       | 39                      | 472          | 7            | 85           | 32                  | 52      | 387          | 21                            | 0.37                                 | 45                                             |
| 3          | 594.5       | 16.5                       | 40                      | 512          | 8            | 102          | 32                  | 61      | 410          | 227                           | 9.37                                 | 20                                             |
| 4          | 595.5       | 20.1                       | 58                      | 904          | 22           | 343          | 36                  | 57      | 561          | 280                           | 9.75                                 | 20                                             |
| 5          | 596.5       | 15.2                       | 34                      | 401          | 0            | 0            | 34                  | 49      | 401          | 0                             | Imp.                                 | -                                              |
| 6          | 597.5       | 13.9                       | 37                      | 399          | 0            | 0            | 37                  | 50      | 399          | 0                             | Imp.                                 | -                                              |
| 7          | 598.5       | 11.5                       | 29                      | 259          | 0            | 0            | 29                  | 66      | 259          | 10                            | 0.15                                 | 35                                             |
| 8          | 599.5       | 19.0                       | 57                      | 840          | 23           | 399          | 34                  | 59      | 501          | 374                           | 9.00                                 | 20                                             |
| 9          | 600.5       | 16.1                       | 41                      | 512          | 8            | 100          | 33                  | 57      | 412          | 18                            | 0.22                                 | 40                                             |
| 10         | 601.5       | 16.5                       | 48                      | 614          | 0            | 0            | 48                  | 34      | 614          | 0                             | Imp.                                 | -                                              |
| 11         | 502.5       | 15.0                       | 37                      | 431          | 0            | 0            | 37                  | 49      | 431          | 0                             | Imp.                                 | -                                              |
| 12         | 503.5       | 15.3                       | 15                      | 178          | 0            | 0            | 15                  | 64      | 178          | 0                             | Imp.                                 | -                                              |
| 13         | 504.5       | 13.7                       | 60                      | 638          | 0            | 0            | 60                  | 16      | 638          | 0                             | Imp.                                 | -                                              |
| 14         | 605.5       | 11.4                       | 33                      | 292          | 0            | 0            | 33                  | 62      | 292          | 0                             | Imp.                                 | -                                              |
| 15         | 606.5       | 10.5                       | 15                      | 133          | 0            | 0            | 15                  | 80      | 133          | 0                             | Imp.                                 | -                                              |

\*Notes: cc—cubic centimeter.

\*—Volume of water recovered at the time of maximum oil recovery.

\*\*—Determined by passing water through sample which still contains residual oil.

# Oilfield Research Laboratories

## SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

|                                                   |                   |       |          |          |    |
|---------------------------------------------------|-------------------|-------|----------|----------|----|
| Company                                           | L & L Oil Company | Lease | Brodbeck | Well No. | 13 |
| Depth Interval, Feet                              | 592.0 - 606.6     |       |          |          |    |
| Feet of Core Analyzed                             | 4.6               |       |          |          |    |
| Average Percent Porosity                          | 17.2              |       |          |          |    |
| Average Percent Original Oil Saturation           | 46.1              |       |          |          |    |
| Average Percent Oil Recovery                      | 12.9              |       |          |          |    |
| Average Percent Residual Oil Saturation           | 33.2              |       |          |          |    |
| Average Percent Residual Water Saturation         | 57.2              |       |          |          |    |
| Average Percent Total Residual Fluid Saturation   | 90.4              |       |          |          |    |
| Average Original Oil Content, Bbls./A. Ft.        | 626.              |       |          |          |    |
| Average Oil Recovery, Bbls./A. Ft.                | 181.              |       |          |          |    |
| Average Residual Oil Content, Bbls./A. Ft.        | 445.              |       |          |          |    |
| Total Original Oil Content, Bbls./Acre            | 2,879.            |       |          |          |    |
| Total Oil Recovery, Bbls./Acre                    | 832.              |       |          |          |    |
| Total Residual Oil Content, Bbls./Acre            | 2,047.            |       |          |          |    |
| Average Effective Permeability, Millidarcys       | 5.39              |       |          |          |    |
| Average Initial Fluid Production Pressure, p.s.i. | 29.0              |       |          |          |    |

NOTE: Only those samples which recovered oil were used in calculating the above averages.

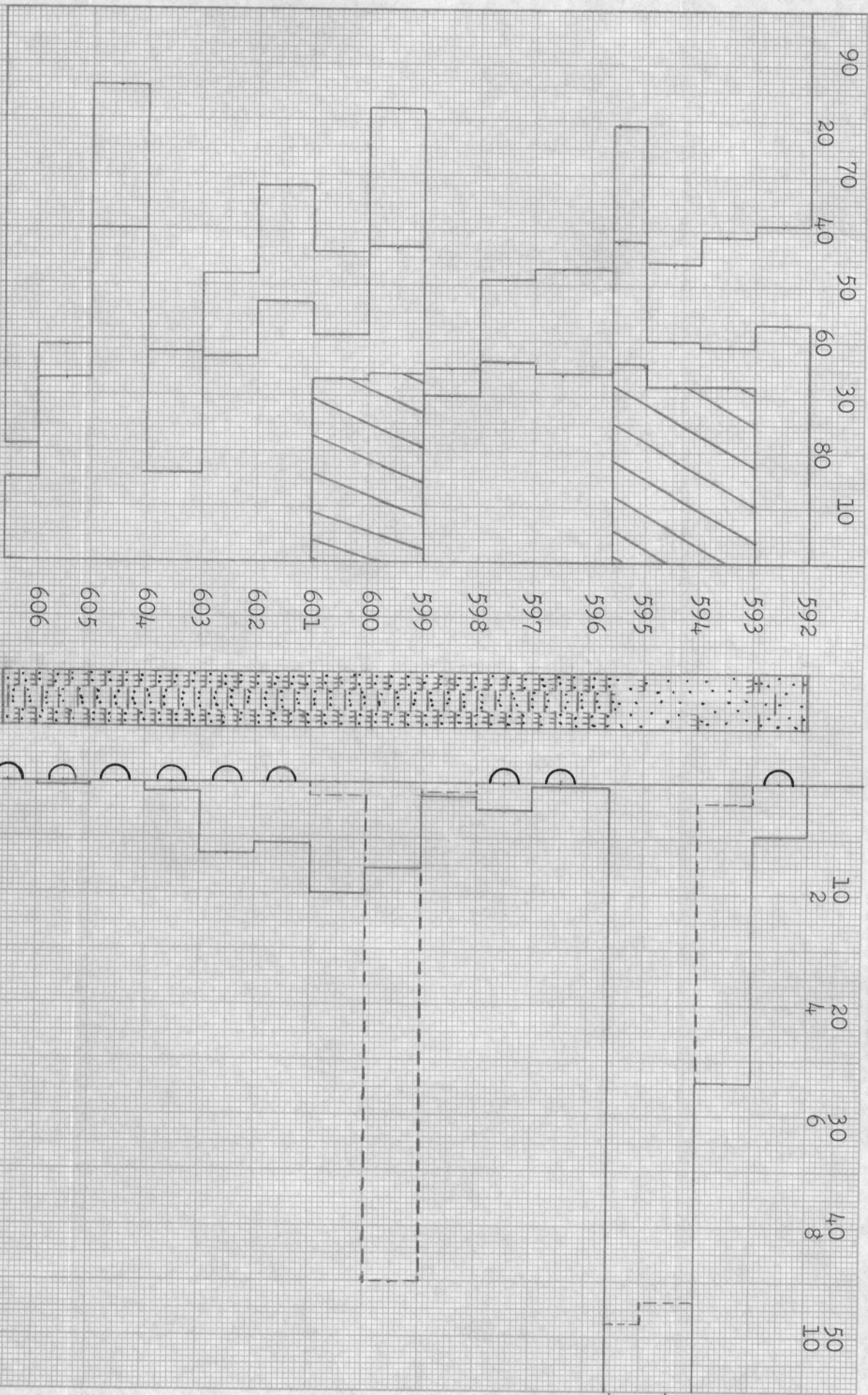


WATER SAT., ———→  
PERCENT

KEY 10 X 10 TO THE CENTIMETER • 25 X 38 CM.  
KEUFFEL & ESSER CO. MADE IN U.S.A.

OIL SAT., ———→  
PERCENT

47 1512  
—— PERMEABILITY, IN MILLIDARCS  
---- EFFECTIVE PERMEABILITY TO WATER,  
IN MILLIDARCS



KEY:



SHALY SANDSTONE



LAMINATED CALCAREOUS SANDSTONE & SHALE



IMPERMEABLE TO WATER

CALCAREOUS SANDSTONE

KEY:



IMPERMEABLE TO WATER



SHALY SANDSTONE



CALCAREOUS SANDSTONE



LAMINATED CALCAREOUS SANDSTONE & SHALE



FLOODPOT RESIDUAL OIL SATURATION

# L & L OIL COMPANY

BRODBECK LEASE

CRAWFORD COUNTY, KANSAS

WELL NO. 13, 13 1/2, NO. 13

| DEPTH INTERVAL,<br>FEET | FEET OF CORE<br>ANALYZED | AVERAGE<br>POROSITY<br>PERCENT | AVG. OIL<br>SATURATION<br>PERCENT | AVG. WATER<br>SATURATION<br>PERCENT | AVERAGE<br>PERMEABILITY<br>MILLIDARCS | CALCULATED<br>OIL RECOVERY<br>BLS./ACRE |
|-------------------------|--------------------------|--------------------------------|-----------------------------------|-------------------------------------|---------------------------------------|-----------------------------------------|
| 592.0 - 606.6           | 14.6                     | 15.1                           | 39.1                              | 44.2                                | 27.4                                  | 1,340                                   |

(PRIMARY &  
WATERFLOODING)

OILFIELD RESEARCH LABORATORIES  
CHANUTE, KANSAS  
OCTOBER, 1980  
SO