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

January 21, 1980

Jackson Brothers
514 North Main
Eureka, Kansas 67045

Gentlemen:

Enclosed herewith is the report of the analysis of the rotary core taken from the Hawthorne Lease, Well No. 12, Greenwood County, Kansas, and submitted to our laboratory on December 19, 1979.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Sanford A. Michel

Sanford A.Michel

SAM/tem
7 c to Eureka, Kansas

# Oilfield Research Laboratories

## GENERAL INFORMATION & SUMMARY

Company Jackson Brothers Lease Hawthorne Well No. 12

Location SW SW SE

Section 22 Twp. 25S Rge. 8E County Greenwood State Kansas

Elevation, Feet Kelly Bushing 5' above Ground Level (Zero) 1457.0 (G.L.)

| | |
|---|---|
| Name of Sand | Bartlesville |
| Top of Core | 2480.0 |
| Bottom of Core | 2505.6 |
| Top of Sand | 2480.0 |
| Bottom of Sand | 2505.6 |
| Total Feet of Permeable Sand | 24.6 |
| Total Feet of Floodable Sand | 9.0 |

| Distribution of Permeable Sand: Permeability Range Millidarcys | Feet | Cum. Ft. |
|---|---|---|
| 0 - 10 | 13.4 | 13.4 |
| 10 - 20 | 8.2 | 21.6 |
| 20 - 30 | 2.1 | 23.7 |
| 40 - 50 | 0.9 | 24.6 |

| | |
|---|---|
| Average Permeability Millidarcys | 10.5 |
| Average Percent Porosity | 16.0 |
| Average Percent Oil Saturation | 21.8 |
| Average Percent Water Saturation | 59.2 |
| Average Oil Content, Bbls./A. Ft. | 266. |
| Total Oil Content, Bbls./Acre | 6,798. |
| Average Percent Oil Recovery by Laboratory Flooding Tests | 4.4 |
| Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft. | 57. |
| Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre | 516. |
| Total Calculated Oil Recovery, Bbls./Acre | See "Calculated Recovery" Section. |

The core was sampled by a representative of Oilfield Research Laboratories. 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:

| Depth Interval, Feet | Description |
|---|---|
| 2480.0 - 2482.0 | Brown and gray laminated sandstone and shale. |
| 2482.0 - 2486.1 | Light brown sandstone. |
| 2486.1 - 2486.8 | Light brown shaly sandstone. |
| 2486.8 - 2489.7 | Light brown sandstone. |
| 2489.7 - 2493.1 | Light brown shaly sandstone. |
| 2493.1 - 2494.0 | Light brown sandstone. |
| 2494.0 - 2495.8 | Light brown shaly sandstone. |
| 2495.8 - 2497.3 | Light brown sandstone. |
| 2497.3 - 2497.9 | Light brown shaly sandstone. |
| 2497.9 - 2502.1 | Light brown sandstone. |
| 2502.1 - 2502.7 | Light brown shaly sandstone. |
| 2502.7 - 2503.7 | Light brown sandstone. |
| 2503.7 - 2504.8 | Light brown shaly sandstone. |
| 2504.8 - 2505.6 | Light brown sandstone. |

## LABORATORY FLOODING TESTS

The sand in this core responded to laboratory flooding tests, as a total recovery of 516 barrels of oil per acre was obtained from 9.0 feet of sand. The weighted average percent oil saturation was reduced from 23.3 to 18.9, or represents an average recovery of 4.4 percent. The weighted average effective permeability of the samples is 0.88 milli-

darcys, while the average initial fluid production pressure is 34.4 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 26 samples tested, 9 produced water and oil, and 5 samples produced water only. This indicates that approximately 35 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sand has a low, uniform permeability profile.

Please note that the coregraph presents residual oil saturation instead of recovery, as in the past.

## CALCULATED RECOVERY

It would appear from a study of the core data, that efficient primary and waterflood operations in the vicinity of this well should recover approximately 1,850 barrels of oil per acre. This is an average recovery of 205 barrels per acre foot from 9.0 feet of floodable sand analyzed in this core.

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

| | |
|---|---|
| Original formation volume factor, estimated | 1.20 |
| Reservoir water saturation, percent, estimated | 40.0 |
| Average porosity, percent | 17.0 |
| Oil saturation after flooding, percent | 18.9 |
| Performance factor, percent, estimated | 50.0 |
| Net floodable sand, feet | 9.0 |

**Oilfield Research Laboratories**

**RESULTS OF SATURATION & PERMEABILITY TESTS**

**TABLE 1-B**

**Company** Jackson Brothers **Lease** Hawthorne **Well No.** 12

| 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 | 2480.5 | 10.1 | 24 | 74 | 98 | 188 | 0.55 | 1.0 | 1.0 | 188 | 0.55 |
| 2 | 2481.5 | 13.4 | 30 | 47 | 77 | 312 | Imp. | 1.0 | 2.0 | 312 | 0.00 |
| 3 | 2482.5 | 17.7 | 21 | 49 | 70 | 288 | 14. | 1.0 | 3.0 | 288 | 14.00 |
| 4 | 2483.5 | 16.8 | 33 | 42 | 75 | 430 | 9.3 | 1.0 | 4.0 | 430 | 9.30 |
| 5 | 2484.5 | 17.7 | 25 | 47 | 72 | 343 | 14. | 1.0 | 5.0 | 343 | 14.00 |
| 6 | 2485.5 | 18.7 | 21 | 50 | 71 | 305 | 24. | 1.1 | 6.1 | 336 | 26.40 |
| 7 | 2486.5 | 17.4 | 24 | 49 | 73 | 324 | 2.3 | 0.7 | 6.8 | 227 | 1.61 |
| 8 | 2487.5 | 15.2 | 27 | 63 | 90 | 318 | 11. | 1.0 | 7.8 | 318 | 11.00 |
| 9 | 2488.5 | 18.2 | 21 | 50 | 71 | 297 | 26. | 1.0 | 8.8 | 297 | 26.00 |
| 10 | 2489.5 | 13.9 | 33 | 65 | 98 | 356 | 44. | 0.9 | 9.7 | 320 | 39.60 |
| 11 | 2490.5 | 15.8 | 22 | 68 | 90 | 270 | 0.47 | 1.0 | 10.7 | 270 | 0.47 |
| 12 | 2491.5 | 16.7 | 12 | 78 | 90 | 156 | 0.59 | 1.4 | 12.1 | 218 | 0.83 |
| 13 | 2492.5 | 16.3 | 17 | 67 | 84 | 215 | 5.3 | 1.0 | 13.1 | 215 | 5.30 |
| 14 | 2493.5 | 19.0 | 13 | 62 | 75 | 192 | 15. | 0.9 | 14.0 | 173 | 13.50 |
| 15 | 2494.5 | 18.0 | 18 | 62 | 80 | 251 | 6.6 | 1.0 | 15.0 | 251 | 6.60 |
| 16 | 2495.5 | 17.4 | 14 | 60 | 74 | 189 | 1.3 | 0.8 | 15.8 | 151 | 1.04 |
| 17 | 2496.5 | 18.4 | 18 | 60 | 78 | 257 | 11. | 1.5 | 17.3 | 386 | 16.50 |
| 18 | 2497.5 | 16.5 | 26 | 51 | 77 | 333 | 3.4 | 0.6 | 17.9 | 200 | 2.04 |
| 19 | 2498.5 | 16.2 | 19 | 58 | 77 | 239 | 11. | 1.0 | 18.9 | 239 | 11.00 |
| 20 | 2499.5 | 15.1 | 26 | 57 | 83 | 305 | 10. | 1.2 | 20.1 | 366 | 12.00 |
| 21 | 2500.5 | 16.4 | 22 | 56 | 78 | 280 | 8.2 | 1.0 | 21.1 | 280 | 8.20 |
| 22 | 2501.5 | 16.0 | 19 | 60 | 79 | 236 | 13. | 1.0 | 22.1 | 236 | 13.00 |
| 23 | 2502.5 | 15.2 | 10 | 87 | 97 | 118 | 3.9 | 0.6 | 22.7 | 71 | 2.34 |
| 24 | 2503.5 | 10.7 | 35 | 60 | 95 | 291 | 8.5 | 1.0 | 23.7 | 291 | 8.50 |
| 25 | 2504.5 | 12.9 | 22 | 62 | 84 | 220 | 2.4 | 1.1 | 24.8 | 242 | 2.64 |
| 26 | 2505.5 | 15.1 | 16 | 53 | 69 | 187 | 14. | 0.8 | 25.6 | 150 | 11.20 |

## Oilfield Research Laboratories

### SUMMARY OF PERMEABILITY & SATURATION TESTS

### TABLE III

Company Jackson Brothers Lease Hawthorne Well No. 12

| Depth Interval, Feet | Feet of Core Analyzed | Average Permeability, Millidarcys | Permeability Capacity Ft. x Md. |
|---|---|---|---|
| 2480.0 - 2489.7 | 8.7 | 16.4 | 142.46 |
| 2489.7 - 2505.6 | 15.9 | 7.2 | 115.16 |
| 2480.0 - 2505.6 | 24.6 | 10.5 | 257.62 |

| Depth Interval, Feet | Feet of Core Analyzed | Average Percent Porosity | Average Percent Oil Saturation | Average Percent Water Saturation | Average Oil Content Bbl./A. Ft. | Total Oil Content Bbls./Acre |
|---|---|---|---|---|---|---|
| 2480.0 - 2489.7 | 9.7 | 15.9 | 25.8 | 53.6 | 315 | 3,059 |
| 2489.7 - 2505.6 | 15.9 | 16.0 | 19.4 | 62.6 | 235 | 3,739 |
| 2480.0 - 2505.6 | 25.6 | 16.0 | 21.8 | 59.2 | 266 | 6,798 |

## Oilfield Research Laboratories

### RESULTS OF LABORATORY FLOODING TESTS

### TABLE IV

Company Jackson Brothers Lease Hawthorne Well No. 12

| 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 | 2480.5 | 10.1 | 24 | 188 | 0 | 0 | 24 | 73 | 188 | 0 | Imp. | - |
| 2 | 2481.5 | 13.1 | 30 | 305 | 0 | 0 | 30 | 51 | 305 | 0 | Imp. | - |
| 3 | 2482.5 | 17.5 | 21 | 285 | 5 | 68 | 16 | 74 | 217 | 36 | 0.80 | 35 |
| 4 | 2483.5 | 16.8 | 33 | 430 | 12 | 156 | 21 | 76 | 274 | 23 | 0.40 | 35 |
| 5 | 2484.5 | 17.5 | 25 | 339 | 4 | 54 | 21 | 77 | 285 | 52 | 1.20 | 35 |
| 6 | 2485.5 | 18.6 | 21 | 303 | 3 | 43 | 18 | 77 | 260 | 41 | 0.60 | 35 |
| 7 | 2486.5 | 17.6 | 24 | 328 | 3 | 41 | 21 | 76 | 287 | 60 | 1.40 | 30 |
| 8 | 2487.5 | 15.4 | 27 | 323 | 0 | 0 | 27 | 70 | 323 | 0 | Imp. | - |
| 9 | 2488.5 | 18.0 | 21 | 293 | 3 | 42 | 18 | 80 | 251 | 56 | 1.00 | 30 |
| 10 | 2489.5 | 14.0 | 33 | 358 | 0 | 0 | 33 | 60 | 358 | 0 | Imp. | - |
| 11 | 2490.5 | 16.1 | 21 | 262 | 0 | 0 | 21 | 70 | 262 | 0 | Imp. | - |
| 12 | 2491.5 | 16.6 | 12 | 154 | 0 | 0 | 12 | 79 | 154 | 0 | Imp. | - |
| 13 | 2492.5 | 16.3 | 17 | 215 | 0 | 0 | 17 | 75 | 215 | 0 | Imp. | - |
| 14 | 2493.5 | 18.7 | 13 | 189 | 0 | 0 | 13 | 85 | 189 | 28 | 0.60 | 35 |
| 15 | 2494.5 | 18.0 | 18 | 251 | 0 | 0 | 18 | 70 | 251 | 0 | Imp. | - |
| 16 | 2495.5 | 17.7 | 14 | 192 | 0 | 0 | 14 | 73 | 192 | 0 | Imp. | - |
| 17 | 2496.5 | 18.1 | 18 | 253 | 0 | 0 | 18 | 72 | 253 | 111 | 3.20 | 30 |
| 18 | 2497.5 | 16.4 | 26 | 330 | 0 | 0 | 26 | 64 | 330 | 0 | Imp. | - |
| 19 | 2498.5 | 16.4 | 19 | 242 | 2 | 25 | 17 | 79 | 217 | 20 | 0.40 | 40 |
| 20 | 2499.5 | 14.9 | 26 | 301 | 5 | 58 | 21 | 76 | 243 | 42 | 1.20 | 35 |
| 21 | 2500.5 | 16.4 | 22 | 280 | 0 | 0 | 21 | 76 | 280 | 15 | 0.60 | 45 |
| 22 | 2501.5 | 16.3 | 19 | 240 | 2 | 25 | 17 | 80 | 215 | 46 | 1.00 | 35 |
| 23 | 2502.5 | 14.9 | 10 | 116 | 0 | 0 | 10 | 85 | 116 | 32 | 0.60 | 45 |
| 24 | 2503.5 | 11.0 | 35 | 299 | 0 | 0 | 35 | 60 | 299 | 0 | Imp. | - |
| 25 | 2504.5 | 12.8 | 22 | 219 | 0 | 0 | 22 | 70 | 219 | 0 | Imp. | - |
| 26 | 2505.5 | 15.3 | 16 | 190 | 0 | 0 | 16 | 82 | 190 | 43 | 0.80 | 35 |

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 Jackson Brothers Lease Hawthorne Well No. 12

| | | | |
|---|---|---|---|
| Depth Interval, Feet | 2480.0 - 2489.7 | 2489.7 - 2505.6 | 2480.0 - 2505.6 |
| Feet of Core Analyzed | 5.8 | 3.2 | 9.0 |
| Average Percent Porosity | 17.7 | 15.8 | 17.0 |
| Average Percent Original Oil Saturation | 24.2 | 21.6 | 23.3 |
| Average Percent Oil Recovery | 5.1 | 3.1 | 4.4 |
| Average Percent Residual Oil Saturation | 19.1 | 18.5 | 18.9 |
| Average Percent Residual Water Saturation | 76.7 | 78.2 | 77.2 |
| Average Percent Total Residual Fluid Saturation | 95.8 | 96.7 | 96.1 |
| Average Original Oil Content, Bbls./A. Ft. | 329. | 263. | 306. |
| Average Oil Recovery, Bbls./A. Ft. | 68. | 37. | 57. |
| Average Residual Oil Content, Bbls./A. Ft. | 261. | 226. | 249. |
| Total Original Oil Content, Bbls./Acre | 1,910. | 844. | 2,754. |
| Total Oil Recovery, Bbls./Acre | 396. | 120. | 516. |
| Total Residual Oil Content, Bbls./Acre | 1,514. | 724. | 2,238. |
| Average Effective Permeability, Millidarcys | 0.87 | 0.89 | 0.88 |
| Average Initial Fluid Production Pressure, p.s.i. | 33.3 | 36.7 | 34.4 |

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

## Oilfield Research Laboratories

**RESULTS OF WATER DIFFERENTIATION TESTS**

**TABLE VI**

Company Jackson Brothers Lease Hawthorne Well No. 12

| Sample No. | Depth, Feet | Chloride Content of Brine in Sand ppm | Percent Water Saturation | | |
|---|---|---|---|---|---|
| | | | Connate | Drilling & Foreign | Total |
| 1 | 2480.5 | 77,473 | | | |
| 2 | 2481.5 | 74,040 | | | |
| 3 | 2482.5 | 12,238 | | | |
| 4 | 2483.5 | 69,378 | | | |
| 5 | 2484.5 | 39,342 | | | |
| 6 | 2485.5 | 23,894 | | | |
| 7 | 2486.5 | 66,148 | | | |
| 8 | 2487.5 | 76,377 | | | |
| 9 | 2488.5 | 18,800 | | | |
| 10 | 2489.5 | 90,478 | | | |
| 11 | 2490.5 | 81,070 | | | |
| 12 | 2491.5 | 74,656 | | | |
| 13 | 2492.5 | 78,126 | | | |
| 14 | 2493.5 | 29,495 | | | |
| 15 | 2494.5 | 83,291 | | | |
| 16 | 2495.5 | 70,542 | | | |
| 17 | 2496.5 | 41,842 | | | |
| 18 | 2497.5 | 91,863 | | | |
| 19 | 2498.5 | 91,164 | | | |
| 20 | 2499.5 | 47,267 | | | |
| 21 | 2500.5 | 63,355 | | | |
| 22 | 2501.5 | 36,448 | | | |
| 23 | 2502.5 | 43,553 | | | |
| 24 | 2503.5 | 41,895 | | | |
| 25 | 2504.5 | 22,232 | | | |
| 26 | 2505.5 | 22,224 | | | |

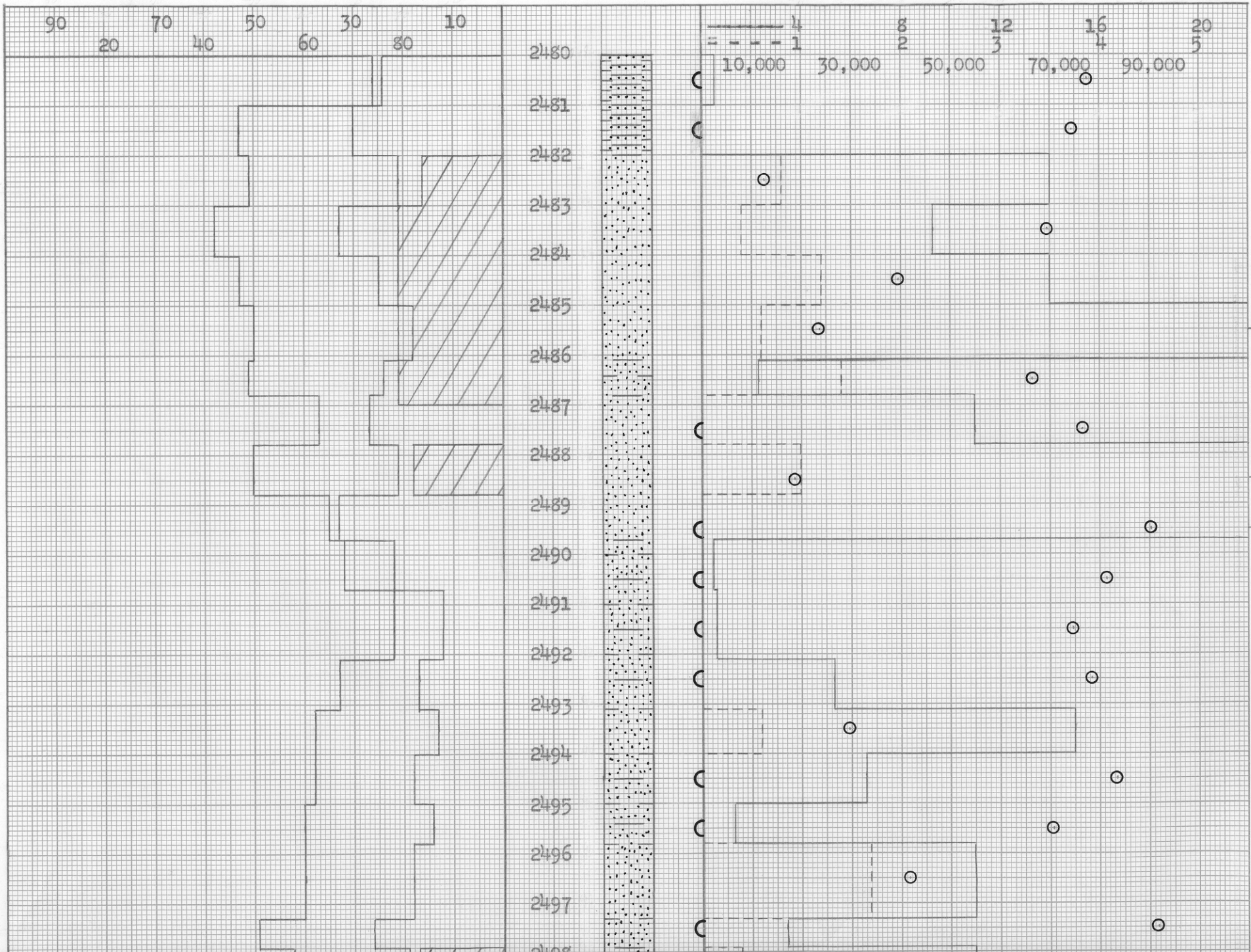
Note: ppm — parts per million

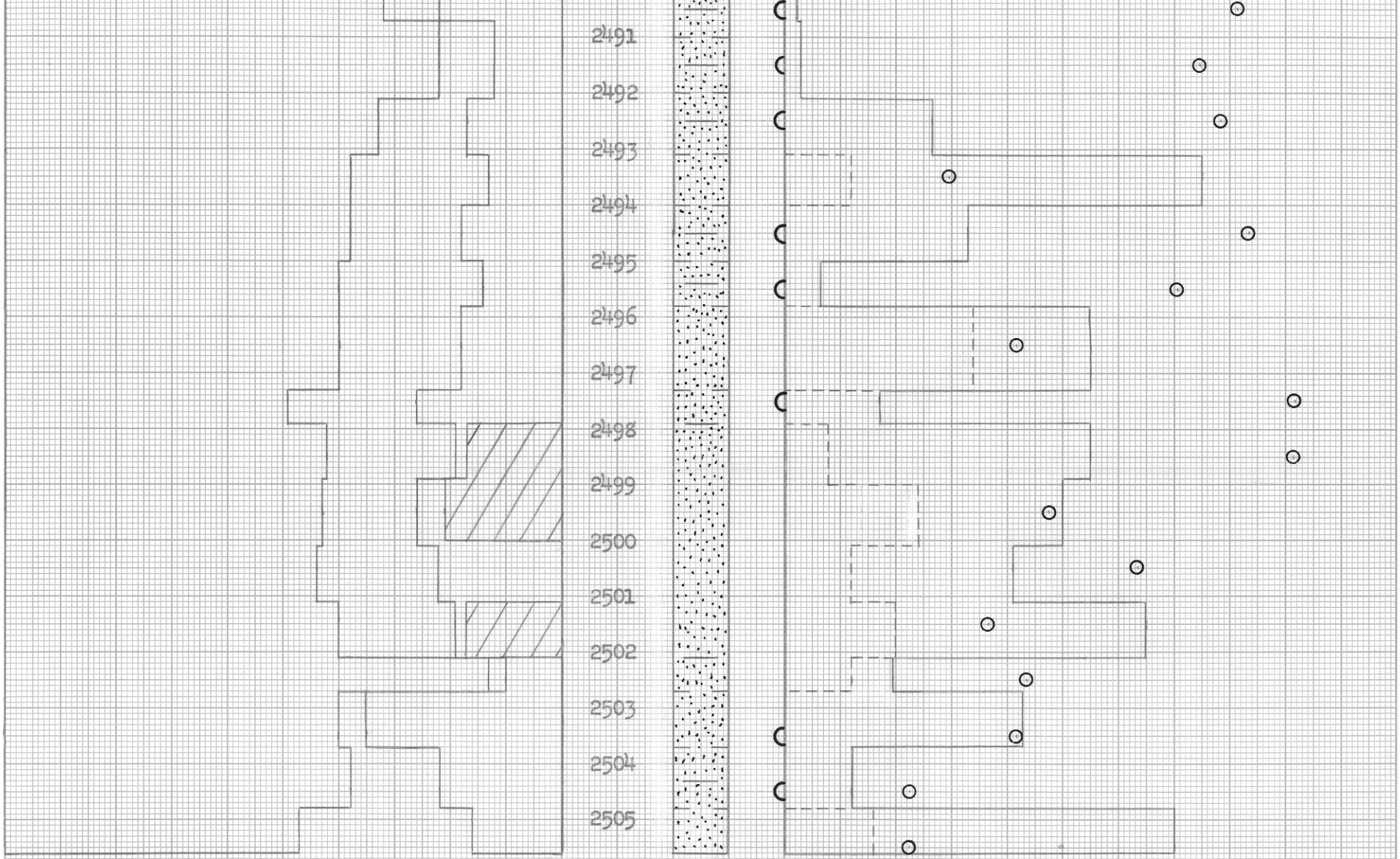
WATER SAT., PERCENT → 90 70 50 30 10 / 20 40 60 80 ← OIL SAT., PERCENT

——— PERMEABILITY, IN MILLIDARCYS

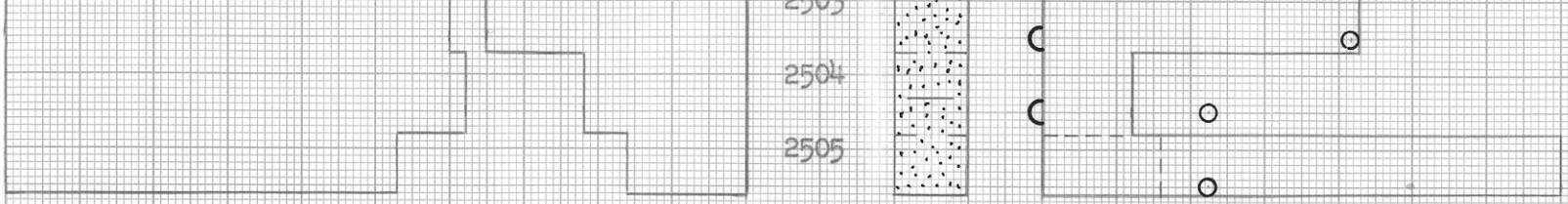
- - - - - EFFECTIVE PERMEABILITY TO WATER, IN MILLIDARCYS

○ CHLORIDE CONTENT OF BRINE IN SAND, PPM




2491
2492
2493
2494
2495
2496
2497
2498
2499
2500
2501
2502
2503
2504
2505

KEY:




KEY:

SANDSTONE

LAMINATED SANDSTONE AND SHALE

IMPERMEABLE TO WATER

SHALY SANDSTONE

FLOODPOT RESIDUAL OIL SATURATION

# JACKSON BROTHERS

HAWTHORNE LEASE WELL NO. 12

GREENWOOD COUNTY, KANSAS

| DEPTH INTERVAL, FEET | FEET OF CORE ANALYZED | AVERAGE PERCENT POROSITY | AVG. OIL SATURATION PERCENT | AVG. WATER SATURATION PERCENT | AVERAGE PERMEABILITY, MILLIDARCYS | CALCULATED OIL RECOVERY BBLS./ACRE |
|---|---|---|---|---|---|---|
| 2480.0 - 2489.7 | 9.7 | 15.9 | 25.8 | 53.6 | 16.4 | |
| 2489.7 - 2505.6 | 15.9 | 16.0 | 19.4 | 62.6 | 7.2 | |
| 2480.0 - 2505.6 | 25.6 | 16.0 | 21.8 | 59.2 | 10.5 | 1,850 (PRIMARY AND WATERFLOODING) |

OILFIELD RESEARCH LABORATORIES
CHANUTE, KANSAS
JANUARY, 1980. HR