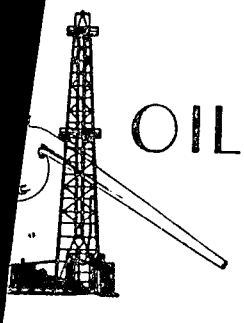


# OILFIELD RESEARCH LABORATORIES

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

API: 15-133-20926 July 13, 1978

Missouri Lead & Zinc Company
1705 North Walnut
Pittsburg, Kansas 66762

Gentlemen:

Enclosed herewith is the report of the analysis of the rotary core taken from the Hiller Lease, Well No. 2, Kansas, and submitted to our laboratory on June 28, 1978.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Carl L. Pate

CLP:ss
4c to Pittsburg, Kansas
1c to Chanute, Kansas

## Oilfield Research Laboratories

### GENERAL INFORMATION & SUMMARY

Company Missouri Lead & Zinc Company Lease Hiller Well No. 2

Location

Section Twp. Rge. County State Kansas

| | |
|---|---|
| Name of Sand | Bartlesville |
| Top of Core (Received) | 166.0 |
| Bottom of Core (Received) | 206.3 |
| Top of Sand (Received) | 177.4 |
| Bottom of ~~Sand~~ Pay | 195.0 |
| Total Feet of Permeable Sand (Analyzed) | 28.3 |
| Total Feet of Floodable Sand | 14.3 |

Distribution of Permeable Sand:

| Permeability Range Millidarcys | Feet | Cum. Ft. |
|---|---|---|
| 0 - 50 | 8.5 | 8.5 |
| 50 - 100 | 10.0 | 18.5 |
| 100 - 200 | 5.3 | 23.8 |
| 200 & above | 4.5 | 28.3 |

| | |
|---|---|
| Average Permeability Millidarcys | 106.9 |
| Average Percent Porosity | 20.6 |
| Average Percent Oil Saturation | 44.8 |
| Average Percent Water Saturation | 35.9 |
| Average Oil Content, Bbls./A. Ft. | 714. |
| Total Oil Content, Bbls./Acre | 20,203. |
| Average Percent Oil Recovery by Laboratory Flooding Tests | 11.0 |
| Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft. | 201. |
| Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre | 3,216. |
| Total Calculated Oil Recovery, Bbls./Acre (Primary & Waterflooding) | 0 4905 4,905. |
| Packer Setting, Feet | |
| Viscosity, Centipoises @ | |
| A. P. I. Gravity, degrees @ 60 °F | |
| Elevation, Feet | |

A fresh water mud was used as a circulating fluid in the coring of the sand in this well. This well was drilled in a virgin area. The core was sampled by a representative of the client.

## FORMATION CORED

The detailed log of the formation cored is as follows:

| Depth Interval, Feet | Description |
|---|---|
| 166.0 - 177.4 | Gray sandy shale. |
| 177.4 - 177.7 | Grayish brown shaly sandstone. |
| 177.7 - 184.5 | Brown slightly laminated carbonaceous sandstone. |
| 184.5 - 186.6 | Light brown laminated carbonaceous shaly sandstone. |
| 186.6 - 190.3 | Brown slightly laminated carbonaceous shaly sandstone. |
| 190.3 - 191.3 | Light brown laminated carbonaceous shaly sandstone. |
| 191.3 - 200.0 | Brown carbonaceous shaly sandstone. |
| 200.0 - 200.6 | Gray calcareous shaly sandstone. |
| 200.6 - 206.3 | Brown slightly carbonaceous shaly sandstone. |

Coring was started at a depth of 166.0 feet in gray sandy shale and completed at 206.3 feet in brown slightly carbonaceous shaly sandstone. This core shows a total of 28.9 feet of sandstone. For the most part, the pay is made up of brown slightly carbonaceous to carbonaceous shaly sandstone.

## PERMEABILITY

For the sake of distribution, the core was divided into three sections. The weighted average permeability of the upper, middle and

lower sections is 228.9, 88.3 and 44.1 millidarcys respectively; the overall average being 106.9 (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has a very irregular permeability profile. The permeability of the sand varies from 6.0 to a maximum of 346 millidarcys.

## PERCENT SATURATION & OIL CONTENT

The sand in this core shows a good weighted average percent oil saturation, namely, 44.8. The weighted average percent oil saturation of the upper, middle and lower sections is 51.8, 45.1 and 37.1 respectively. The weighted average percent water saturation of the upper, middle and lower sections is 19.6, 35.7 and 47.0 respectively; the overall average being 35.9 (See Table III). This gives an overall weighted average total fluid saturation of 80.7 percent. This fairly low total fluid saturation indicates that some fluid was lost during coring which was probably oil.

The weighted average oil content of the upper, middle and lower sections is 958, 728 and 538 barrels per acre foot respectively; the overall average being 714. The total oil content, as shown by this core, is 20,203 barrels per acre of which 14,443 barrels are in the pay sand section. (See Table III).

## LABORATORY FLOODING TESTS

Part of the sand in this core responded fairly well to laboratory flooding tests, as a total recovery of 3,216 barrels of oil per acre was obtained from 16.0 feet of sand. The weighted average percent oil saturation was reduced from 48.5 to 37.5, or represents a

average recovery of 11.0 percent. The weighted average effective permeability of the samples is 16.28 millidarcys, while the average initial fluid production pressure is 16.1 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 21 samples tested, 18 produced water and 16 oil. This indicates that approximately 34 percent of the sand represented by these samples is floodable pay sand.

## CONCLUSION

From a study of the above data we estimate approximatley 4,905 barrels of oil per acre can be recovered from the sand reservoir, represented by this core, by efficient primary and waterflood operations provided the injected water can be confined to the pay sand section (177.4 to 195.0 feet). The following data and assumptions were used in calculating the above oil recovery value:

| | |
|---|---|
| Original formation volume factor | 1.01 / 1.03 |
| Irreducible water saturation, percent | 18.0 / 25.0 |
| Primary recovery | None |
| Present oil saturation, percent | 81.2 |
| Average porosity, percent | 22.5 / 22.8 |
| Oil saturation after flooding, percent | 37.5 / 33.9 |
| Performance factor | 0.45 |
| Net floodable pay sand, feet | 14.3 / 9.0 |

The core shows a fairly clean pay sand section having a good oil saturation, a rather low water saturation and a good permeability and porosity.

**Oilfield Research Laboratories**

**RESULTS OF SATURATION & PERMEABILITY TESTS**

**TABLE 1-B**

Company Missouri Lead & Zinc Company Lease Hiller Well No. 2

| 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 | 177.6 | 13.4 | 32 | 56 | 88 | 333 | 94. | 0.3 | 0.3 | 100 | 28.20 |
| 2 | 178.5 | 22.5 | 45 | 17 | 62 | 787 | 169. | 1.3 | 1.6 | 1023 | 219.70 |
| 3 | 179.5 | (5) 24.7 | 42 | 19 | 61 | 807 | 153. (5) | 1.0 | 2.6 | 807 | 153.00 |
| 4 | 180.5 | 24.9 | 67 | 7 | 74 | 1297 | 319. | 1.0 | 3.6 | 1297 | 319.00 |
| 5 | 181.5 | 25.0 122.7 | 56 58 | 14 18 | 70 | 1089 1936 | 133. 112.0 | 1.0 | 4.6 | 1089 | 133.00 |
| 6 | 182.5 | 25.6 24.5 | 48 52.5 | 21 15.5 | 69 | 956 987 | 346. 224 | 1.0 | 5.6 | 956 1172 | 346.00 |
| 7 | 183.5 | 22.6 | 58 | 26 | 84 | 1019 | 284. | 1.5 | 7.1 | 1528 | 426.00 |
| 8 | 184.7 | 20.7 | 43 | 33 | 76 | 692 | 72. | 0.6 | 7.7 | 415 | 43.20 |
| 9 | 185.5 | 20.7 | 47 | 32 | 79 | 757 | 57. | 0.9 | 8.6 | 681 | 51.30 |
| 10 | 186.5 | 20.2 | 47 | 40 | 87 | 738 | 128. | 0.6 | 9.2 | 443 | 76.80 |
| 11 | 187.5 | 22.8 | 44 | 36 | 80 | 780 | 115. | 1.4 | 10.6 | 1092 | 161.00 |
| 12 | 188.5 | 20.0 | 43 | 43 | 86 | 669 | 226. | 1.0 | 11.6 | 669 | 226.00 |
| 13 | 189.5 | 22.4 | 47 | 30 | 77 | 817 | 90. | 1.3 | 12.9 | 1062 | 117.00 |
| 14 | 190.5 | 16.7 | 38 | 44 | 82 | 492 | 69. | 1.0 | 13.9 | 492 | 69.00 |
| 15 | 191.5 | 20.7 | 48 | 36 | 84 | 771 | 71. | 0.7 | 14.6 | 540 | 49.70 |
| 16 | 192.5 | 20.4 | 53 | 32 | 85 | 839 | 21. | 1.0 | 15.6 | 839 | 21.00 |
| 17 | 193.5 | 20.4 | 44 | 33 | 77 | 696 | 59. | 1.0 | 16.6 | 696 | 59.00 |
| 18 | 194.5 | 21.4 | 43 | 36 | 79 | 714 | 53. | 1.0 | 17.6 | 714 | 53.00 |
| 19 | 195.5 | 20.7 | 36 | 43 | 79 | 578 | 39. | 1.0 | 18.6 | 578 | 39.00 |
| 20 | 196.5 | 18.4 | 39 | 44 | 83 | 557 | 12. | 1.0 | 19.6 | 557 | 12.00 |
| 21 | 197.5 | 20.2 | 36 | 45 | 81 | 564 | 39. | 1.0 | 20.6 | 564 | 39.00 |
| 22 | 198.4 | 19.1 | 47 | 35 | 82 | 696 | 6.0 | 1.0 | 21.6 | 696 | 6.00 |
| 23 | 199.5 | 18.9 | 40 | 46 | 86 | 587 | 28. | 1.0 | 22.6 | 587 | 28.00 |
| 24 | 200.8 | 10.5 | 20 | 62 | 82 | 163 | 38. | 0.5 | 23.1 | 81 | 19.00 |
| 25 | 201.5 | 18.4 | 33 | 52 | 85 | 471 | 76. | 0.9 | 24.0 | 424 | 68.40 |
| 26 | 202.4 | 17.6 | 40 | 48 | 88 | 546 | 57. | 0.9 | 24.9 | 491 | 51.30 |
| 27 | 203.4 | 16.6 | 40 | 54 | 94 | 515 | 74. | 1.1 | 26.0 | 566 | 81.40 |
| 28 | 204.5 | 19.9 | 26 | 43 | 69 | 401 | 32. | 1.0 | 27.0 | 401 | 32.00 |
| 29 | 205.5 | 19.7 | 41 | 51 | 92 | 627 | 74. | 1.3 | 28.3 | 815 | 96.20 |
| | 4743.9 | 511.5 | | 869 | | | 2682 | | | | |

## Oilfield Research Laboratories

### SUMMARY OF PERMEABILITY & SATURATION TESTS

### TABLE III

Company Missouri Lead & Zinc Company Lease Hiller Well No. 2

| Depth Interval, Feet | Feet of Core Analyzed | Average Permeability, Millidarcys | Permeability Capacity Ft. x Md. |
|---|---|---|---|
| 177.4 - 184.5 | 7.1 | 228.9 | 1,624.90 |
| 184.5 - 195.0 | 10.5 | 88.3 | 927.00 |
| 195.0 - 206.3 | 10.7 | 44.1 | 472.30 |
| 177.4 - 206.3 | 28.3 | 106.9 | 3,024.20 |

| 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 |
|---|---|---|---|---|---|---|
| 177.4 - 184.5 | 7.1 | 23.6 | 51.8 | 19.6 | 958 | 6,800 |
| 184.5 - 195.0 | 10.5 | 20.7 | 45.1 | 35.7 | 728 | 7,643 |
| 195.0 - 206.3 | 10.7 | 18.6 | 37.1 | 47.0 | 538 | 5,760 |
| 177.4 - 206.3 | 28.3 | 20.6 | 44.8 | 35.9 | 714 | 20,203 |

## RESULTS OF LABORATORY FLOODING TESTS

### TABLE IV

Company Missouri Lead & Zinc Company Lease Hiller Well No. 2

| 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 | 177.6 | 15.3 | 32 | 380 | 5 | 59 | 27 | 66 | 321 | 322 | 12.91 | 15 |
| 2 | 178.5 | 23.1 | 45 | 806 | 11 24.4 | 197 | 34 | 61 | 609 | 396 | 26.55 | 15 |
| 3 | 179.5 | 25.6 | 42 | 834 | 13 30.9 | 258 | 29 | 65 | 576 | 163 | 19.99 | 15 |
| 4 | 180.5 | 24.6 | 67 | 1279 | 32 47.7 | 611 | 35 | 62 | 668 | 439 | 20.82 | 10 |
| 5 | 181.5 | 24.8 | 56 | 1077 | 18 32.1 | 346 | 38 | 57 | 731 | 428 | 45.80 | 10 |
| 6 | 182.5 | 24.0 | 48 | 894 | 16 33.3 | 298 | 32 | 63 | 596 | 157 | 21.66 | 15 |
| 7 | 183.5 | 24.3 | 58 | 1093 | 25 43.1 | 471 | 33 | 64 | 622 | 180 | 20.82 | 10 |
| 8 | 184.7 | 22.4 | 43 | 748 | 7 16.3 | 122 | 36 | 56 | 626 | 320 | 13.01 | 15 |
| 9 | 185.5 | 21.5 | 47 | 784 | 6 12.7 | 100 | 41 | 57 | 684 | 361 | 15.09 | 15 |
| 10 | 186.5 | 20.2 | 47 | 738 | 0 | 0 | 47 | 40 | 738 | 0 | Imp. | - |
| 11 | 187.5 | 23.2 | 44 | 792 | 4 | 72 | 40 | 56 | 720 | 283 | 16.66 | 5 |
| 12 | 188.5 | 19.1 | 43 | 638 | 2 | 30 | 41 | 50 | 608 | 16 | 0.50 | 35 |
| 13 | 189.5 | 21.7 | 47 | 792 | 7 | 118 | 40 | 46 | 674 | 58 | 1.33 | 25 |
| 14 | 190.5 | 16.7 | 38 | 492 | 0 | 0 | 38 | 44 | 492 | 0 | Imp. | - |
| 15 | 191.5 | 20.6 | 48 | 767 | 3 | 48 | 45 | 45 | 719 | 20 | 0.58 | 30 |
| 16 | 192.5 | 20.4 | 53 | 839 | 10 | 158 | 43 | 57 | 681 | 136 | 4.50 | 25 |
| 17 | 193.5 | 21.7 | 44 | 741 | 3 | 51 | 41 | 56 | 690 | 290 | 22.21 | 10 |
| 18 | 194.5 | 21.3 | 43 | 711 | 2 | 33 | 41 | 55 | 678 | 276 | 8.50 | 15 |
| 19 | 195.5 | 20.3 | 37 | 583 | 0 | 0 | 37 | 54 | 583 | 86 | 2.17 | 15 |
| 20 | 196.5 | 18.4 | 39 | 557 | 0 | 0 | 39 | 44 | 557 | 0 | Imp. | - |
| 21 | 197.5 | 20.4 | 34 | 538 | 0 | 0 | 34 | 54 | 538 | 366 | 10.64 | 15 |
| | | | | | | | 508 | 1600.9 | | | 337.34 | |
| | | | | | | | 11 : 1.9 = 33.9 | | | | | |

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

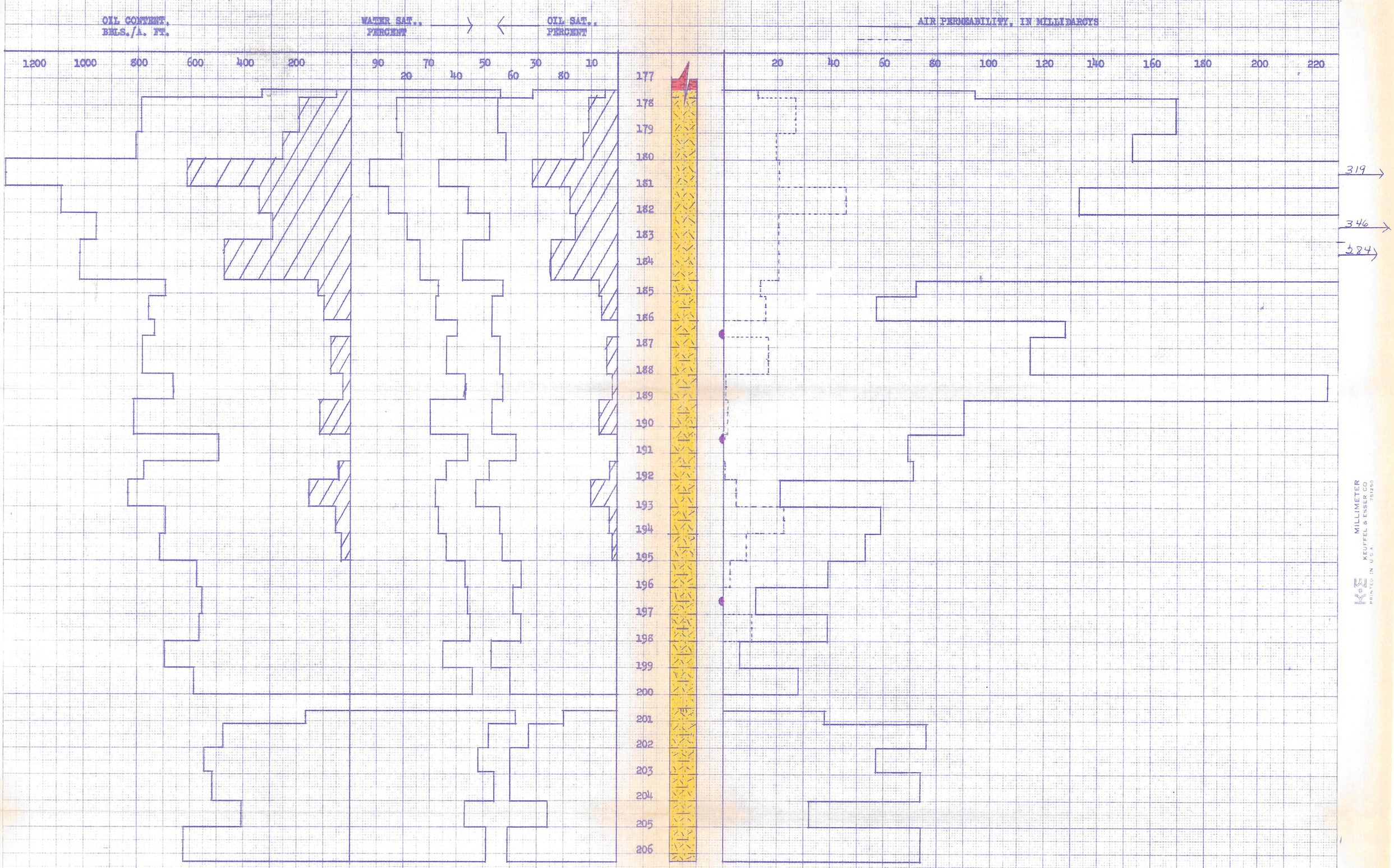
### SUMMARY OF LABORATORY FLOODING TESTS

### TABLE V

Company Missouri Lead & Zinc Company Lease Hiller Well No. 2

| | | | |
|---|---|---|---|
| Depth Interval, Feet | 177.4 - 184.5 | 184.5 - 195.0 | 177.4 - 195.0 |
| Feet of Core Analyzed | 7.1 | 8.9 | 16.0 |
| Average Percent Porosity | 23.9 | 21.4 | 22.5 |
| Average Percent Original Oil Saturation | 51.8 | 45.8 | 48.5 |
| Average Percent Oil Recovery | 18.6 | 4.9 | 11.0 |
| Average Percent Residual Oil Saturation | 33.2 | 40.9 | 37.5 |
| Average Percent Residual Water Saturation | 62.3 | 53.1 | 57.2 |
| Average Percent Total Residual Fluid Saturation | 95.5 | 94.0 | 94.7 |
| Average Original Oil Content, Bbls./A. Ft. | 970. | 759. | 853. |
| Average Oil Recovery, Bbls./A. Ft. | 351. | 81. | 201. |
| Average Residual Oil Content, Bbls./A. Ft. | 619. | 678. | 652. |
| Total Original Oil Content, Bbls./Acre | 6,885. | 6,759. | 13,644. |
| Total Oil Recovery, Bbls./Acre | 2,493. | 723. | 3,216. |
| Total Residual Oil Content, Bbls./Acre | 4,392. | 6,036. | 10,428. |
| Average Effective Permeability, Millidarcys | 25.05 | 9.28 | 16.28 |
| Average Initial Fluid Production Pressure, p.s.i. | 12.5 | 18.9 | 16.1 |

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




KEY:

- FLOOD POT RECOVERY
- SANDY SHALE
- CALCAREOUS SHALY SANDSTONE
- SHALY SANDSTONE
- CARBONACEOUS SANDSTONE
- CARBONACEOUS SHALY SANDSTONE
- IMPERMEABLE TO WATER

# MISSOURI LEAD & ZINC COMPANY

HILLER LEASE — WELL NO. 2

| DEPTH INTERVAL, FEET | FEET OF CORE ANALYZED | AVERAGE PERCENT POROSITY | AVG. OIL SATURATION, PERCENT | AVG. WATER SATURATION, PERCENT | AVG. OIL CONTENT, BBLS./A. FT. | TOTAL OIL CONTENT, BBLS./ACRE | AVG. AIR PERMEABILITY, MILLIDARCYS | CALCULATED OIL RECOVERY, BBLS./ACRE |
|---|---|---|---|---|---|---|---|---|
| 177.4 - 184.5 | 7.1 | 23.6 | 51.8 | 19.6 | 958 | 6,800 | 228.9 | |
| 184.5 - 195.0 | 10.5 | 20.7 | 45.1 | 35.7 | 728 | 7,643 | 88.3 | |
| 195.0 - 206.3 | 10.7 | 18.6 | 37.1 | 47.0 | 538 | 5,760 | 44.1 | |
| 177.4 - 206.3 | 28.3 | 20.6 | 44.8 | 35.9 | 714 | 20,203 | 106.9 | 4,905 (PRIMARY & WATERFLOODING) |

OILFIELD RESEARCH LABORATORIES
CHANUTE, KANSAS
JULY, 1978
S.S.