



OILFIELD RESEARCH LABORATORIES

536 NORTH HIGHLAND - CHANUTE, KANSAS - PHONE HE1-2650

March 10, 1967

Virgyl D. Johnson
Suite 1119 Mid City Building
1331 Union Avenue
Memphis, Tennessee

Gentlemen:

Enclosed herewith is the report of the analysis of the Rotary core taken from the Westhoff Lease, Well No. 15, Crawford County, Kansas, and submitted to our laboratory on March 7, 1967.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Benjamin R. Pearman
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BRP:rf

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GENERAL INFORMATION & SUMMARY

| | | | | | | |
|---|---------------------------|--------|----------|----------|--------------|--------|
| Company | Virgyl D. Johnson | Lease | Westhoff | Well No. | 15 | |
| Location | SW SE NW | | | | | |
| Section | 5 | Twp | 29S | Rge. | 22E | |
| | | County | Crawford | | State | Kansas |
| Name of Sand | - - - - - | | | | Bartlesville | |
| Top of Core | - - - - - | | | | 397.0 | |
| Bottom of Core | - - - - - | | | | 416.0 | |
| Top of Sand | - - - - - | | | | 398.2 | |
| Bottom of Sand | - - - - - | | | | 408.1 | |
| Total Feet of Permeable Sand | - - - - - | | | | 9.9 | |
| Total Feet of Floodable Sand | - - - - - | | | | 7.0 | |
| Distribution of Permeable Sand: | | | | | | |
| Permeability Range Millidarcys | Feet | | Cum. Ft. | | | |
| | | | | | | |
| 3 - 10 | 3.9 | | 3.9 | | | |
| 10 - 30 | 6.0 | | 9.9 | | | |
| | | | | | | |
| Average Permeability Millidarcys | - - - - - | | | | 13.9 | |
| Average Percent Porosity | - - - - - | | | | 18.4 | |
| Average Percent Oil Saturation | - - - - - | | | | 48.8 | |
| Average Percent Water Saturation | - - - - - | | | | 34.8 | |
| Average Oil Content, Bbls./A. Ft. | - - - - - | | | | 695. | |
| Total Oil Content, Bbls./Acre | - - - - - | | | | 6,888. | |
| Average Percent Oil Recovery by Laboratory Flooding Tests | - - - - - | | | | 6.4 | |
| Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft. | - - - - - | | | | 92. | |
| Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre | - - - - - | | | | 642. | |
| Total Calculated Oil Recovery, Bbls./Acre | - (Primary & Secondary) - | | | | 1,530. | |
| Packer Setting, Feet | - - - - - | | | | | |
| Viscosity, Centipoises @ | - - - - - | | | | | |
| A. P. I. Gravity, degrees @ 60 °F | - - - - - | | | | | |
| Elevation, Feet | - - - - - | | | | | |

Fresh water mud was used as the circulating fluid while taking this core. The core was sampled and the samples sealed in cans by a representative of Oilfield Research Laboratories. The well was drilled in virgin territory.

FORMATION CORED

The detailed log of the formation cored is as follows:

| <u>Depth Interval,</u> | <u>Description</u> |
|------------------------|--------------------|
| <u>Feet</u> | |

| | |
|---------------|---------------------|
| 397.0 - 398.2 | - Gray sandy shale. |
|---------------|---------------------|

| | |
|---------------|--------------------------------------|
| 398.2 - 405.6 | - Brown, laminated, shaly sandstone. |
|---------------|--------------------------------------|

| | |
|---------------|--|
| 405.6 - 406.6 | - Dark, slightly carbonaceous, laminated, shaly sandstone. |
|---------------|--|

| | |
|---------------|--------------------------------|
| 406.6 - 408.1 | - Dark carbonaceous sandstone. |
|---------------|--------------------------------|

| | |
|---------------|----------|
| 408.1 - 416.0 | - Shale. |
|---------------|----------|

Coring was started at a depth of 397.0 feet in shale and completed at 416.0 feet also in shale. This core shows a total of 9.9 feet of sandstone. For the most part, the pay is made up of brown, laminated, shaly sandstone.

PERMEABILITY

The weighted average permeability of the core is 13.9 millidarcys (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has a fairly regular permeability profile. The permeability of the sand varies from 3.8 to a maximum of 29. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a good weighted average percent oil saturation, namely, 48.8. The weighted average percent water satura-

tion is 34.8 (See Table III). This gives an overall weighted average total fluid saturation of 83.6 percent.

The weighted average oil content of the core is 695 barrels per acre foot. The total oil content, as shown by this core, is 6,888 barrels per acre (See Table III).

LABORATORY FLOODING TESTS

The sand in this core responded to laboratory flooding tests, as a total recovery of 642 barrels of oil per acre was obtained from 7.0 feet of sand. The weighted average percent oil saturation was reduced from 45.3 to 38.9, or represents an average recovery of 6.4 percent. The weighted average effective permeability of the samples is 0.235 millidarcys, while the average initial fluid production pressure is 40.0 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 10 samples tested, 8 produced water and 7 oil. This indicates that approximately 70 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sand has a fairly uniform effective permeability to water.

CONCLUSION

Based on the results of the laboratory tests, it appears that efficient primary and secondary operations in the vicinity of this well should recover approximately 1,530 barrels of oil per acre or an average of 218 barrels per acre foot from the 7.0 feet of floodable pay sand analyzed in this core. These recovery values were calculated using the following data and assumptions:

| | |
|--|------|
| Original formation volume factor | 1.03 |
| Reservoir water saturation, percent | 30.0 |
| Average porosity, percent | 18.7 |
| Oil saturation after flooding, percent | 38.9 |
| Performance factor, percent | 50.0 |
| Net floodable pay sand, feet | 7.0 |

This core shows a pay sand section having a good oil saturation, a moderate water saturation and fairly uniform effective permeability to water. The above secondary recovery values were calculated assuming that satisfactory injection rates will be maintained throughout the flood life of the property.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company Virgyl D. Johnson Lease Westhoff Well No. 15

| Sample No. | Depth, Feet | Effective Porosity Percent | Percent Saturation | | Oil Content Bbbls. / A Ft. | Perm., Mill. | Feet of Sand | | Total Oil Content | Perm. Capacity Ft. X md. | |
|------------|-------------|----------------------------|--------------------|-------|----------------------------|--------------|--------------|----------|-------------------|--------------------------|--|
| | | | Oil | Water | | | Ft. | Cum. Ft. | | | |
| 1 | 398.4 | 18.4 | 59 | 33 | 840 | 5.2 | 0.4 | 0.4 | 336 | 2.08 | |
| 2 | 399.1 | 18.4 | 47 | 35 | 670 | 20. | 1.0 | 1.4 | 670 | 20.00 | |
| 3 | 400.1 | 18.8 | 44 | 32 | 641 | 6.1 | 1.0 | 2.4 | 641 | 6.10 | |
| 4 | 401.1 | 19.2 | 51 | 44 | 759 | 18. | 1.0 | 3.4 | 759 | 18.00 | |
| 5 | 402.1 | 17.7 | 51 | 38 | 699 | 29. | 1.0 | 4.4 | 699 | 29.00 | |
| 6 | 403.1 | 18.3 | 40 | 34 | 568 | 17. | 1.0 | 5.4 | 568 | 17.00 | |
| 7 | 404.1 | 19.7 | 37 | 40 | 565 | 3.8 | 1.0 | 6.4 | 565 | 3.80 | |
| 8 | 405.1 | 18.4 | 47 | 35 | 670 | 23. | 1.0 | 7.4 | 670 | 23.00 | |
| 9 | 406.1 | 18.1 | 53 | 33 | 743 | 11. | 1.0 | 8.4 | 743 | 11.00 | |
| 10 | 407.1 | 17.7 | 60 | 27 | 823 | 5.1 | 1.5 | 9.9 | 1,237 | 7.65 | |
| Total | | | | | | | ----- | | 6,888 | | |

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company Virgyl D. Johnson Lessee Westhoff Well No. 15

| Depth Interval, Feet | Feet of Core Analyzed | Average Permeability, Millidarcys | Permeability Capacity Ft. x Md. |
|-------------------------|--------------------------|---|---------------------------------------|
| 398.2 - 408.1 | 9.9 | 13.9 | 137.63 |

| 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 |
|-------------------------|--------------------------|--------------------------------|--------------------------------------|--|---------------------------------------|------------------------------------|
| 398.2 - 408.1 | 9.9 | 18.4 | 48.8 | 34.8 | 695 | 6,888 |

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

| 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 | | | |
| 1 | 398.4 | 18.1 | 60 | 843 | 0 | 0 | 60 | 33 | 0 | Imp. | - |
| 2 | 399.1 | 18.7 | 47 | 682 | 4 | 58 | 43 | 51 | 21 | 0.375 | 30 |
| 3 | 400.1 | 18.5 | 44 | 630 | 2 | 29 | 42 | 55 | 5 | 0.133 | 50 |
| 4 | 401.1 | 19.0 | 51 | 750 | 8 | 118 | 43 | 56 | 8 | 0.160 | 50 |
| 5 | 402.1 | 17.5 | 51 | 691 | 16 | 217 | 35 | 64 | 20 | 0.313 | 30 |
| 6 | 403.1 | 18.8 | 40 | 583 | 7 | 102 | 33 | 66 | 8 | 0.140 | 40 |
| 7 | 404.1 | 19.4 | 37 | 556 | 2 | 30 | 35 | 60 | 2 | 0.075 | 50 |
| 8 | 405.1 | 18.8 | 47 | 685 | 6 | 88 | 41 | 57 | 27 | 0.450 | 30 |
| 9 | 406.1 | 17.9 | 53 | 736 | 0 | 0 | 53 | 45 | 3 | 0.163 | 50 |
| 10 | 407.1 | 17.8 | 62 | 855 | 0 | 0 | 62 | 28 | 0 | Imp. | - |

Company **Virgyl D. Johnson** Lease **Westhoff** Well No. **15**

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.

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SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

| | | | | | |
|---|-------------------|-------|----------|----------|----|
| Company | Virgyl D. Johnson | Lease | Westhoff | Well No. | 15 |
| Depth Interval, Feet | 398.2 - 408.1 | | | | |
| Feet of Core Analyzed | 7.0 | | | | |
| Average Percent Porosity | 18.7 | | | | |
| Average Percent Original Oil Saturation | 45.3 | | | | |
| Average Percent Oil Recovery | 6.4 | | | | |
| Average Percent Residual Oil Saturation | 38.9 | | | | |
| Average Percent Residual Water Saturation | 58.5 | | | | |
| Average Percent Total Residual Fluid Saturation | 97.4 | | | | |
| Average Original Oil Content, Bbls./A. Ft. | 653. | | | | |
| Average Oil Recovery, Bbls./A. Ft. | 92. | | | | |
| Average Residual Oil Content, Bbls./A. Ft. | 561. | | | | |
| Total Original Oil Content, Bbls./Acre | 4,577. | | | | |
| Total Oil Recovery, Bbls./Acre | 642. | | | | |
| Total Residual Oil Content, Bbls./Acre | 3,935. | | | | |
| Average Effective Permeability, Millidarcys | 0.235 | | | | |
| Average Initial Fluid Production Pressure, p.s.i. | 40.0 | | | | |

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