

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

G.K. Jackson

Company Jackson Bros. Lease Heirs Well No. 2

Location SE NW SW

Section 23 Twp. 25S Rge. 8E County Greenwood State Kansas

|                                  |                      |              |
|----------------------------------|----------------------|--------------|
| Name of Sand                     | - - - - -            | Bartlesville |
| Top of Core                      | - - - - -            | 2438.0       |
| Bottom of Core                   | - - - - -            | 2468.0       |
| Top of <sup>Permeable</sup> Sand | - - - - -            | 2455.6       |
| Bottom of Sand                   | - - - - -            | 2463.6       |
| Total Feet of Permeable Sand     | (Analyzed) - - - - - | 5.8          |
| Total Feet of Floodable Sand     | - - - - -            | 5.6          |

| Distribution of Permeable Sand:<br>Permeability Range<br>Millidarcys | Feet | Cum. Ft. |
|--|------|----------|
| 0 - 1  | 1.6  | 1.6      |
| 1 - 10   | 2.2  | 3.8      |
| 10 & above   | 2.0  | 5.8      |

|   |                                 |        |
|---|---------------------------------|--------|
| Average Permeability Millidarcys                                | - - - - -                       | 8.7    |
| Average Percent Porosity  | - - - - -                       | 16.3   |
| Average Percent Oil Saturation                                  | - - - - -                       | 24.8   |
| Average Percent Water Saturation                                | - - - - -                       | 52.8   |
| Average Oil Content, Bbls./A. Ft.                               | - - - - -                       | 324.   |
| Total Oil Content, Bbls./Acre                                   | - - - - -                       | 3,041. |
| Average Percent Oil Recovery by Laboratory Flooding Tests       | - - - - -                       | 5.4    |
| Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft. | - - - - -                       | 77.    |
| Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre     | - - - - -                       | 384.   |
| Total Calculated Oil Recovery, Bbls./Acre                       | (Primary & Secondary) - - - - - | 1,694. |
| 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 Oilfield Research Laboratories.

#### FORMATION CORED

The detailed log of the formation cored is as follows:

| <u>Depth Interval,</u><br><u>Feet</u> | <u>Description</u>                               |
|---------------------------------------|--|
| 2438.0 - 2451.0                       | - Shale.   |
| 2451.0 - 2452.2                       | - Gray shaly sandstone.                          |
| 2452.2 - 2455.0                       | - Gray sandy limestone.                          |
| 2455.0 - 2463.6                       | - Grayish light brown, slightly shaly sandstone. |
| 2463.6 - 2468.0                       | - Shale.   |

Coring was started at a depth of 2438.0 feet in shale and completed at 2468.0 feet in the same type of material. This core shows a total of 10.8 feet of sandstone. For the most part, the pay is made up of grayish light brown, slightly shaly sandstone.

#### PERMEABILITY

For the sake of distribution, the core was divided into two sections. The weighted average permeability of the upper and lower sections is 1.7 and 11.8 millidarcys respectively; the overall average being 8.7 (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 impermeable to a maximum of 20. millidarcys.

#### PERCENT SATURATION & OIL CONTENT

The sand in this core shows a low weighted average percent oil saturation, namely, 24.8. The weighted average percent oil saturation of the upper and lower sections is 24.5 and 25.0 respectively. The weighted average percent water saturation of the upper and lower sections

is 60.7 and 46.1 respectively; the overall average being 52.8 (See Table III). This gives an overall weighted average total fluid saturation of 77.6 percent. This fairly low total fluid saturation indicates some fluid was lost during coring which was probably oil.

In an effort to determine whether or not any flushing of the sand occurred during coring, all of the saturation samples were analyzed for chloride content. The results of these tests are given in Tables VI and VII. From the data given in these tables and on the coregraph, it is evident that some flushing did occur during coring, especially in the lower part of the sand section.

The weighted average oil content of the upper and lower sections is 267 and 362 barrels per acre foot respectively; the overall average being 324. The total oil content, as shown by this core, is 3,041 barrels per acre (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 384 barrels of oil per acre was obtained from 5.0 feet of sand. The weighted average percent oil saturation was reduced from 24.8 to 19.4, or represents an average recovery of 5.4 percent. The weighted average effective permeability of the samples is 0.78 millidarcys, while the average initial fluid production pressure is 36.8 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 10 samples tested, 7 produced water and 6 oil. This indicates that approximately 60 percent of the sand represented by these samples is floodable pay sand.

#### CONCLUSION

From a study of the above data we estimate that approximately 938

barrels of oil per acre can be recovered from the area, represented by this core, by efficient primary production methods. An additional oil recovery of approximately 756 barrels of oil per acre or an average of 135 barrels per acre foot can be expected from efficient water-flooding. The following data and assumptions were used in calculating the above oil recovery values:

|  |       |
|--|-------|
| Original formation volume factor       | 1.21  |
| Present formation volume factor        | -     |
| Reservoir water saturation, percent    | 40.0  |
| Primary recovery, estimated, percent   | None. |
| Present oil saturation, percent        | 51.6  |
| Average porosity, percent              | 17.9  |
| Oil saturation after flooding, percent | 19.4  |
| Performance factor, percent            | 50.0  |
| Net floodable pay sand, feet           | 5.6   |

This core shows a thin sand section having a low oil saturation, a high water saturation and a low average permeability. No doubt, some core oil was lost during the cutting of the core; partly due to gas expansion and invasion of circulating fluid.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company Jackson Brothers

Lease G.K. Jackson Heirs

Well No. 2

| Sample No. | Depth, Feet | Effective Porosity Percent | Percent Saturation |       |       | Oil Content<br>Bbls. / A Ft. | Perm.,<br>M.D. | Feet of Sand |          | Total Oil Content | Perm. Capacity<br>Ft. X md. |
|------------|-------------|----------------------------|--------------------|-------|-------|------------------------------|----------------|--------------|----------|-------------------|-----------------------------|
|            |             |                            | Oil                | Water | Total |                              |                | Ft.          | Cum. Ft. |                   |                             |
| 1          | 2451.9      | 13.7                       | 9                  | 76    | 85    | 96                           | Imp.           | 1.0          | 1.0      | 96                | 0.00                        |
| 2          | 2455.1      | 12.0                       | 41                 | 38    | 79    | 332                          | Imp.           | 0.6          | 1.6      | 229               | 0.00                        |
| 3          | 2456.1      | 14.1                       | 32                 | 60    | 92    | 350                          | 0.87           | 1.0          | 2.6      | 350               | 0.87                        |
| 4          | 2457.1      | 15.0                       | 21                 | 59    | 80    | 244                          | 0.74           | 0.6          | 3.2      | 146               | 0.44                        |
| F-4        | 2457.3      | 16.6                       | 25                 | -     | -     | 322                          | -              | 0.6          | 3.8      | 193               | -                           |
| P-5        | 2457.9      | -                          | -                  | -     | -     | -                            | 8.7            | 0.2          | 4.0      | -                 | 1.74                        |
| 5          | 2458.1      | 17.3                       | 23                 | 51    | 74    | 309                          | -              | 0.6          | 4.6      | 281               | -                           |
| 6          | 2459.1      | 18.3                       | 26                 | 43    | 69    | 369                          | 7.0            | 1.0          | 5.6      | 369               | 7.00                        |
| 7          | 2460.1      | 15.7                       | 27                 | 55    | 82    | 329                          | Imp.           | 0.6          | 6.2      | 197               | 0.00                        |
| F-7        | 2460.3      | 16.4                       | 23                 | -     | -     | 293                          | -              | 0.4          | 6.6      | 117               | -                           |
| 8          | 2461.1      | 18.4                       | 23                 | 49    | 72    | 328                          | 8.2            | 1.0          | 7.6      | 328               | 8.20                        |
| 9          | 2462.1      | 18.4                       | 29                 | 50    | 79    | 414                          | 12.            | 1.0          | 8.6      | 414               | 12.00                       |
| 10         | 2463.1      | 18.0                       | 23                 | 44    | 67    | 321                          | 20.            | 1.0          | 9.6      | 321               | 20.00                       |

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company Jackson Brothers Lease G. K. Jackson Heirs Well No. 2

| Depth Interval,<br>Feet | Feet of Core<br>Analyzed | Average<br>Permeability,<br>Millidarcys | Permeability<br>Capacity<br>Ft. x Md. |
|-------------------------|--------------------------|---|---------------------------------------|
| 2455.6 - 2458.0         | 1.8                      | 1.7                                     | 3.05                                  |
| 2458.0 - 2463.6         | 4.0                      | 11.8                                    | 47.20                                 |
| 2455.6 - 2463.6         | 5.8                      | 8.7                                     | 50.25                                 |

| Depth Interval,<br>Feet | Feet of Core<br>Analyzed | Average<br>Percent<br>Porosity | Average<br>Percent Oil<br>Saturation | Average<br>Percent Water<br>Saturation | Average<br>Oil Content<br>Bbl./A. Ft. | Total Oil<br>Content<br>Bbls./Acre |
|-------------------------|--------------------------|--------------------------------|--------------------------------------|--|---------------------------------------|------------------------------------|
| 2451.2 - 2457.8         | 3.8                      | 14.2                           | 24.5                                 | 60.7                                   | 267                                   | 1,014.                             |
| 2458.0 - 2463.6         | 5.6                      | 17.8                           | 25.0                                 | 46.1                                   | 362                                   | 2,027.                             |
| 2451.2 - 2463.6         | 9.4                      | 16.3                           | 24.8                                 | 52.8                                   | 324                                   | 3,041                              |

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company Jackson Brothers Name G.K. Jackson Heirs Well 2

| Sample No. | Depth, Feet | Relative Permeability Percent | Original Oil Saturation |             | Oil Recovery |             | Residual Saturation |         |             | Volume of Water Recovered cc* | Relative Permeability (Residual) <sup>cc</sup> | Initial Fluid Production Pressure Lbs./Sq./In. |
|------------|-------------|-------------------------------|-------------------------|-------------|--------------|-------------|---------------------|---------|-------------|-------------------------------|--|--|
|            |             |                               | %                       | ccs./A.F.T. | %            | ccs./A.F.T. | % Oil               | % Water | ccs./A.F.T. |                               |  |  |
| 1          | 2451.9      | 13.2                          | 7                       | 72          | 0            | 0           | 7                   | 80      | 72          | 0                             | Imp.   | -  |
| 2          | 2455.1      | 12.4                          | 37                      | 356         | 0            | 0           | 37                  | 44      | 356         | 0                             | Imp.   | -  |
| 3          | 2456.1      | 13.6                          | 30                      | 316         | 0            | 0           | 30                  | 65      | 316         | 0                             | Imp.   | -  |
| 4          | 2457.3      | 15.6                          | 25                      | 322         | 0            | 0           | 25                  | 60      | 322         | 17                            | 0.700  | 40   |
| 5          | 2458.1      | 17.4                          | 23                      | 310         | 3            | 40          | 20                  | 70      | 270         | 25                            | 1.25   | 40   |
| 6          | 2459.1      | 17.8                          | 26                      | 359         | 5            | 69          | 21                  | 67      | 290         | 8                             | 0.376  | 40   |
| 7          | 2460.3      | 15.4                          | 23                      | 293         | 1            | 13          | 22                  | 68      | 280         | 6                             | 0.200  | 50   |
| 8          | 2461.1      | 17.9                          | 23                      | 320         | 3            | 42          | 20                  | 72      | 278         | 10                            | 0.500  | 40   |
| 9          | 2462.1      | 18.5                          | 29                      | 416         | 11           | 158         | 18                  | 69      | 258         | 11                            | 0.500  | 40   |
| 10         | 2463.1      | 18.4                          | 23                      | 329         | 6            | 86          | 17                  | 78      | 243         | 56                            | 1.70   | 20   |

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   | Jackson Brothers | Well No. | 2                  |
|   |                  | Location | G.K. Jackson Heirs |
| Depth Interval, Feet                              | 2458.0 - 2463.6  |          |                    |
| Feet of Core Analyzed                             | 5.0              |          |                    |
| Average Percent Porosity                          | 17.9             |          |                    |
| Average Percent Original Oil Saturation           | 24.8             |          |                    |
| Average Percent Oil Recovery                      | 5.4              |          |                    |
| Average Percent Residual Oil Saturation           | 19.4             |          |                    |
| Average Percent Residual Water Saturation         | 71.0             |          |                    |
| Average Percent Total Residual Fluid Saturation   | 90.4             |          |                    |
| Average Original Oil Content, Bbls./A. Ft.        | 346.             |          |                    |
| Average Oil Recovery, Bbls./A. Ft.                | 77.              |          |                    |
| Average Residual Oil Content, Bbls./A. Ft.        | 269.             |          |                    |
| Total Original Oil Content, Bbls./Acre            | 1727.            |          |                    |
| Total Oil Recovery, Bbls./Acre                    | 384.             |          |                    |
| Total Residual Oil Content, Bbls./Acre            | 1343.            |          |                    |
| Average Effective Permeability, Millidarcys       | 0.78             |          |                    |
| Average Initial Fluid Production Pressure, p.s.i. | 36.8             |          |                    |

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

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**RESULTS OF WATER DIFFERENTIATION TESTS**

**TABLE VI**

Company Jackson Brothers Lease G.K. Jackson Heirs Well No. 2

| Sample No. | Depth, Feet | Chloride Content of Brine in Sand<br>ppm | Percent Connate | Water Saturation<br>Drilling &<br>Foreign | Total |
|------------|-------------|--|-----------------|---|-------|
| 1          | 2451.9      | 96,300                                   |                 |   |       |
| 2          | 2455.1      | 139,000                                  |                 |   |       |
| 3          | 2456.1      | 112,450                                  |                 |   |       |
| 4          | 2457.1      | 95,300                                   |                 |   |       |
| 5          | 2458.1      | 88,850                                   |                 |   |       |
| 6          | 2459.1      | 97,600                                   |                 |   |       |
| 7          | 2460.1      | 87,600                                   |                 |   |       |
| 8          | 2461.1      | 103,000                                  |                 |   |       |
| 9          | 2462.1      | 87,500                                   |                 |   |       |
| 10         | 2463.1      | 92,700                                   |                 |   |       |

Note: ppm — parts per million

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SUMMARY OF WATER DIFFERENTIATION TESTS

TABLE VII

Company Jackson Brothers Lease G.K. Jackson Heirs Well No. 2

| <u>Depth Interval,<br/>Feet</u> | <u>Chloride Content<br/>of Brine in Sand,<br/>ppm</u> | <u>Average Percent<br/>Connate Water</u> | <u>Average Percent<br/>Drilling &amp;<br/>Foreign Water</u> |
|---------------------------------|---|--|---|
| 2451.2 - 2457.2                 | 91,934  |  |   |
| 2458.0 - 2463.6                 | 86,920  |  |   |
| 2451.2 - 2463.6                 | 88,947  |  |   |

Note: ppm — parts per million.