● CORE ANALYSIS ● WATER REPRESSURING ENGINEERING ● WATER ANALYSIS ● FLOODING WATER TREATMENT ● SURVEYING

OILFIELD RESEARCH LABORATORIES

- REGISTERED ENGINEERS -

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June 8, 1959

Jackson Brothers
514 North Main
Eureka, Kansas

Gentlemen:

Enclosed herewith is the report of the analysis of the 3½" Rotary core taken from the Crews Lease, Well No. 3, Greenwood County, Kansas, and submitted to our laboratory on June 1, 1959.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Carl L. McElrea

Carl L. McElrea

CLM:cs

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Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company Jackson Brothers Lease Crews Well No. 3

Location 900' W. of E. Line and 250' S. of N. Line, NW¼

Section 3 Twp. 26S Rge. 8E County Greenwood State Kansas

Name of Sand	Cattleman
Top of Core	2388.0
Bottom of Core	2402.0
Top of Sand	?
Bottom of Sand	2400.0
Total Feet of Permeable Sand	9.6
Total Feet of Floodable Sand	

Distribution of Permeable Sand: Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 5	3.4	3.4
5 - 20	2.1	5.5
20 - 40	2.3	7.8
40 & above	1.8	9.6

Average Permeability Millidarcys	23.2
Average Percent Porosity	14.7
Average Percent Oil Saturation	14.5
Average Percent Water Saturation	63.4
Average Oil Content, Bbls./A. Ft.	165.
Total Oil Content, Bbls./Acre	1,792.
Average Percent Oil Recovery by Laboratory Flooding Tests	
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	
Total Calculated Oil Recovery, Bbls./Acre	
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

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GENERAL INFORMATION & SUMMARY

Company Jackson Brothers Lease Crews Well No. 3

Location 900' W. of E. Line and 250' S. of N. Line, NW¼

Section 3 Twp. 26S Rge. 8E County Greenwood State Kansas

Name of Sand	Bartlesville
Top of Core	2530.0
Bottom of Core	2560.0
Top of Pay Sand	2538.7
Bottom of Pay Sand	2550.6
Total Feet of Permeable Sand	16.0
Total Feet of Floodable Sand	11.9

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 2	3.5	3.5
2 - 8	3.0	6.5
8 - 16	2.0	8.5
16 - 24	1.8	10.3
24 - 32	3.7	14.0
32 & above	2.0	16.0

Average Permeability Millidarcys	16.2
Average Percent Porosity	19.9
Average Percent Oil Saturation	17.3
Average Percent Water Saturation	62.7
Average Oil Content, Bbls./A. Ft.	272.
Total Oil Content, Bbls./Acre	5,608.
Average Percent Oil Recovery by Laboratory Flooding Tests	3.6
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	60.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	710.
Total Calculated Oil Recovery, Bbls./Acre	2,400.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

Cores were taken from the Cattleman and Bartlesville sands in this well. A fresh water mud was used as the circulating fluid during the coring of both sands.

The cores were sampled and the samples sealed in plastic bags by a representative of Oilfield Research Laboratories. The core of the Cattleman sand had been washed and was exposed to air for approximately 10 hours before samples were taken.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
	CATTLEMAN SAND
2388.0 - 2388.5	Hard fine grained micaceous carbonaceous slightly calcareous sandstone.
2388.5 - 2391.0	Gray fine grained slightly laminated micaceous calcareous shaley sandstone.
2391.0 - 2391.6	Brown fine grained micaceous sandstone.
2391.6 - 2392.7	Brown and gray fine grained micaceous slightly shaley sandstone.
2392.7 - 2392.8	Shale.
2392.8 - 2395.0	Grayish light brown fine grained slightly laminated micaceous shaley sandstone.
2395.0 - 2395.2	Brown fine grained micaceous sandstone.
2395.2 - 2397.8	Grayish light brown fine grained micaceous sandstone.
2397.8 - 2400.0	Laminated shaley sandstone.
2400.0 - 2402.0	Sandy shale (Discarded at well).
2402.0 - 2530.0	Drilled with tools.
	BARTLESVILLE SAND
2530.0 - 2533.0	Shale (Discarded at well).
2533.0 - 2534.8	Gray sandy shale.
2534.8 - 2535.7	Gray fine grained micaceous shaley sandstone.

2535.7 - 2538.7 - Grayish light brown fine grained micaceous slightly shaley sandstone.

2538.7 - 2539.5 - Grayish light brown fine grained micaceous sandstone.

2539.5 - 2554.2 - Grayish light brown fine grained micaceous slightly shaley sandstone.

2554.2 - 2555.5 - Shale.

2555.5 - 2556.7 - Gray sandy shale.

2556.7 - 2557.0 - Dark shale.

2557.0 - 2560.0 - Dark shale (Discarded at well).

A complete analysis was run on the Bartlesville core. Porosity, oil and water saturation determinations and permeability tests were run on the Cattleman core. The following discussion is concerned with the results of the complete analysis run on the Bartlesville core.

Coring was started at a depth of 2530.0 feet in shale and completed at 2560.0 feet in dark shale. This core shows a total of 24.9 feet of sandstone. For the most part, the pay is made up of grayish light brown fine grained micaceous slightly shaley 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 1.0, 20.5 and 10.9 millidarcys respectively; the overall average being 16.2 (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 0.46 to a maximum of 49 millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a low weighted average percent oil saturation, namely, 17.3. The weighted average percent oil saturation of the upper, middle and lower sections is 13.9, 19.8 and 14.0 respectively.

The weighted average percent water saturation of the upper, middle and lower sections is 69.0, 58.4 and 72.5 respectively; the overall average being 62.7 (See Table III). This gives an overall weighted average total fluid saturation of 80.0 percent. This total fluid saturation indicates some fluid was lost during coring, part of which probably was oil.

The weighted average oil content of the upper, middle and lower sections is 187, 329 and 200 barrels per acre foot respectively; the overall average being 272. The total oil content, as shown by this core, is 5,608 barrels per acre of which 3,918 barrels are in the middle 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 710 barrels of oil per acre was obtained from 11.9 feet of sand. The weighted average percent oil saturation was reduced from 19.8 to 16.2, or represents an average recovery of 3.6 percent. The weighted average effective permeability of the samples is 2.71 millidarcys, while the average initial fluid production pressure is 27.1 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 20 samples tested, 13 produced water and 12 oil. This indicates that approximately 60 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.

CONCLUSION

It is evident from the enclosed data that an efficient water-flood, within the vicinity of this well, will recover approximately 2,400 barrels of oil per acre, or an average of 202 barrels of oil per acre foot from the 11.9 feet of floodable pay sand analyzed. The following factors and

assumptions were used in calculating this recovery:

Original formation volume factor	1.19
Present formation volume factor	1.05
True water saturation, percent	42.0
Primary oil recovery, percent	5.0
Calculated present oil saturation, percent	46.2
Porosity, percent	21.6
Oil saturation at abandonment, percent	20.0
Performance factor	0.50

The analysis results show 11.9 feet of floodable pay sand in the interval extending from 2538.7 to 2550.6 feet. The floodable sand has low oil and high water saturations, and good effective permeability. The low oil and high water saturations are probably partly due to flushing of the sand with circulating fluid during coring.

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RESULTS OF PERMEABILITY TESTS

TABLE I

Company Jackson Brothers Lease Crews Well No. 3

Sample No.	Depth Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
		CATTLEMAN SAND			
1	2388.3	2.3	0.5	0.5	1.15
2	2388.9	8.4	0.6	1.1	5.04
3	2389.3	6.7	0.5	1.6	3.35
4	2389.9	30.	0.5	2.1	15.00
5	2390.3	25.	0.5	2.6	12.50
6	2390.9	8.4	0.4	3.0	3.36
7	2391.3	53.	0.6	3.6	31.80
8	2391.9	30.	0.5	4.1	15.00
9	2392.3	15.	0.6	4.7	9.00
10	2392.9	0.63	0.3	5.0	0.19
11	2393.3	2.2	0.5	5.5	1.10
12	2393.9	24.	0.8	6.3	19.20
13	2394.9	128.	0.6	6.9	76.80
14	2395.3	1.6	0.4	7.3	0.64
15	2395.9	43.	0.6	7.9	25.80
16	2397.3	0.96	0.8	8.7	0.77
17	2397.9	2.3	0.3	9.0	0.69
18	2398.3	1.5	0.6	9.6	0.90
		BARTLESVILLE SAND			
1	2534.9	Imp.	0.4	0.4	0.00
2	2535.4	Imp.	0.5	0.9	0.00
3	2535.9	0.48	0.5	1.4	0.24
4	2536.4	1.9	0.5	1.9	0.95
5	2536.9	1.4	0.5	2.4	0.70
6	2537.4	0.46	0.5	2.9	0.23
7	2537.9	Imp.	0.5	3.4	0.00
8	2538.4	0.76	0.5	3.9	0.38
9	2538.9	8.5	0.5	4.4	4.25
10	2539.4	17.	0.3	4.7	5.10
11	2539.9	31.	0.7	5.4	21.70
12	2540.4	25.	0.5	5.9	12.50
13	2540.9	21.	0.5	6.4	10.50
14	2541.4	49.	0.5	6.9	24.50
15	2541.9	32.	0.5	7.4	16.00
16	2542.4	30.	0.5	7.9	15.00
17	2542.9	26.	0.5	8.4	13.00
18	2543.4	41.	0.5	8.9	20.50
19	2543.9	14.	0.5	9.4	7.00
20	2544.4	7.7	0.5	9.9	3.85

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RESULTS OF PERMEABILITY TESTS

TABLE I

Company Jackson Brothers Lease Crews Well No. 3

Sample No.	Depth Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
21	2544.9	24.	0.5	10.4	12.00
22	2545.4	9.6	0.5	10.9	4.80
23	2545.9	26.	0.5	11.4	13.00
24	2546.4	1.4	0.5	11.9	0.70
25	2546.9	48.	0.5	12.4	24.00
26	2547.4	20.	0.5	12.9	10.00
27	2547.9	17.	0.5	13.4	8.50
28	2548.4	Imp.	0.5	13.9	0.00
29	2548.9	0.58	0.5	14.4	0.29
30	2549.4	6.8	0.5	14.9	3.40
31	2549.9	4.4	0.5	15.4	2.20
32	2550.4	2.8	0.5	15.9	1.40
33	2550.9	Imp.	0.5	16.4	0.00
34	2551.4	Imp.	0.5	16.9	0.00
35	2551.9	24.	0.5	17.4	12.00
36	2552.4	Imp.	0.5	17.9	0.00
37	2552.9	3.9	0.5	18.4	1.95
38	2553.4	7.8	0.5	18.9	3.90
39	2553.9	9.5	0.5	19.4	4.75
40	2555.7	Imp.	0.5	19.9	0.00
41	2556.2	Imp.	0.7	20.6	0.00

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RESULTS OF SATURATION TESTS

TABLE II

Company Jackson Brothers Lease Crews Well No. 3

Sat. No.	Depth, Feet	Effective Porosity Percent	Percent Saturation			Oil Content Bbls./A. Ft.	Feet of Core		Total Oil Content Bbls./Acre
			Oil	Water	Total		Ft.	Cum. Ft.	
				CATTLEMAN SAND					
1	2388.1	7.1	12	77	89	66	0.5	0.5	33
2	2389.1	12.6	10	69	79	100	1.1	1.6	110
3	2390.1	11.9	27	45	72	249	1.4	3.0	349
4	2391.1	19.0	26	42	68	383	0.6	3.6	230
5	2392.1	19.5	8	61	69	121	1.1	4.7	133
6	2393.1	18.0	30	67	97	419	0.8	5.5	335
7	2394.1	17.5	6	76	82	82	1.4	6.9	115
8	2395.1	21.8	38	30	68	642	0.2	7.1	128
9	2396.1	16.9	5	66	71	66	1.4	8.5	92
10	2397.1	9.6	15	57	72	112	1.2	9.7	134
11	2398.1	11.9	12	78	90	111	1.2	10.9	133
							Total-	- - - - -	-1,792
				HARTLESVILLE SAND					
1	2535.1	15.5	8	78	86	96	0.9	0.9	86
2	2536.1	22.2	14	51	65	241	0.9	1.8	217
3	2537.1	15.6	20	75	95	242	1.0	2.8	242
4	2538.1	16.6	13	71	84	167	1.1	3.9	184
5	2539.1	21.3	21	55	76	346	0.8	4.7	277
6	2540.1	22.9	20	61	81	355	1.1	5.8	391
7	2541.1	21.3	18	63	81	297	1.0	6.8	297
8	2542.1	22.1	22	56	78	377	1.0	7.8	377
9	2543.1	21.7	15	62	77	252	1.0	8.8	252
10	2544.1	22.3	20	62	82	346	1.0	9.8	346

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RESULTS OF SATURATION TESTS

TABLE II

Company Jackson Brothers Lease Crews Well No. 3

Sat. No.	Depth, Feet	Effective Porosity Percent	Percent Saturation			Oil Content Bbls./A. Ft.	Feet of Core		Total Oil Content Bbls./Acre
			Oil	Water	Total		Ft.	Cum. Ft.	
11	2545.1	20.4	17	60	77	268	1.0	10.8	268
12	2546.1	19.9	24	59	83	370	1.0	11.8	370
13	2547.1	22.5	18	59	77	314	1.0	12.8	314
14	2548.1	20.5	19	64	83	302	1.0	13.8	302
15	2549.1	21.5	22	42	64	366	1.0	14.8	366
16	2550.1	21.0	22	57	79	358	1.0	15.8	358
17	2551.1	18.0	16	64	80	223	1.0	16.8	223
18	2552.1	16.5	17	72	89	217	1.0	17.8	217
19	2553.1	20.7	17	65	82	272	1.6	19.4	435
20	2555.9	15.4	6	90	96	72	1.2	20.6	86
							Total-	- - - - -	-5,608

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company Jackson Brothers Lease Crews Well No. 3

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
	CATTLEMAN SAND		
2388.0 - 2398.7	9.6	23.2	222.29
	BARTLESVILLE SAND		
2535.7 - 2538.7	2.5	1.0	2.50
2538.7 - 2550.6	11.4	20.5	233.91
2550.6 - 2554.2	2.1	10.9	22.88
2535.7 - 2554.2	16.0	16.2	259.29

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
			CATTLEMAN SAND			
2388.0 - 2399.0	10.9	14.7	14.5	63.4	165	1,792
			BARTLESVILLE SAND			
2534.8 - 2538.7	3.9	17.4	13.9	69.0	187	729
2538.7 - 2550.6	11.9	21.5	19.8	58.4	329	3,918
2550.6 - 2556.7	4.8	17.9	14.0	72.5	200	961
2534.8 - 2556.7	20.6	19.9	17.3	62.7	272	5,608

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company Jackson Brothers Lease Crews Well No. 3

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.			
					BARTLESVILLE SAND							
1	2535.1	16.0	5	62	0	0	5	88	62	0	Imp.	50+
2	2536.1	21.8	16	270	0	0	16	74	270	0	Imp.	50+
3	2537.1	16.2	17	213	0	0	17	77	213	0	Imp.	50+
4	2538.1	17.2	15	200	0	0	15	74	200	0	Imp.	50+
5	2539.1	21.7	21	353	2	34	19	72	319	17	0.420	40
6	2540.1	23.1	20	358	2	36	18	76	322	176	3.63	25
7	2541.1	21.6	18	301	3	50	15	83	251	127	3.25	25
8	2542.1	22.3	22	380	3	52	19	77	328	79	2.15	25
9	2543.1	22.3	15	259	2	35	13	78	224	169	5.34	25
10	2544.1	22.9	20	355	3	53	17	77	302	142	5.60	25
11	2545.1	20.4	17	216	1	13	16	82	203	55	1.40	25
12	2546.1	20.3	24	377	4	63	20	72	314	38	0.960	35
13	2547.1	21.9	18	305	3	51	15	81	254	112	3.07	25
14	2548.1	21.0	19	309	6	98	13	86	211	122	3.18	25
15	2549.1	21.0	22	358	9	147	13	82	211	74	2.03	25
16	2550.1	21.0	22	358	5	81	17	75	277	38	0.908	25
17	2551.1	18.1	15	210	0	0	15	78	210	0	Imp.	50+
18	2552.1	17.0	15	197	0	0	15	83	197	0	Imp.	50+
19	2553.1	20.8	14	226	0	0	14	75	226	7	0.207	40
20	2555.9	14.9	4	46	0	0	4	89	46	0	Imp.	50+

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 Crews Well No. 3

	BARTLESVILLE SAND
Depth Interval, Feet	2538.7 - 2550.6
Feet of Core Analyzed	11.9
Average Percent Porosity	21.6
Average Percent Original Oil Saturation	19.8
Average Percent Oil Recovery	3.6
Average Percent Residual Oil Saturation	16.2
Average Percent Residual Water Saturation	78.4
Average Percent Total Residual Fluid Saturation	94.6
Average Original Oil Content, Bbls./A. Ft.	328.
Average Oil Recovery, Bbls./A. Ft.	60.
Average Residual Oil Content, Bbls./A. Ft.	268.
Total Original Oil Content, Bbls./Acre	3,894.
Total Oil Recovery, Bbls./Acre	710.
Total Residual Oil Content, Bbls./Acre	3,184.
Average Effective Permeability, Millidarcys	2.71
Average Initial Fluid Production Pressure, p.s.i.	27.1

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