



OILFIELD RESEARCH LABORATORIES

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

August 26, 1968

Jackson Brothers
514 North Main
Eureka, Kansas 67045

Gentlemen:

Enclosed herewith is the report of the analysis of the Rotary core taken from the Crew Lease, Well No. 21, Greenwood County, Kansas, and submitted to our laboratory on August 21, 1968.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Carl L. Pate

CLP:dp

6 c. - Eureka, Kansas

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GENERAL INFORMATION & SUMMARY

Company Jackson Brothers Lease Crew Well No. 21

Location NW NE NE

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

Name of Sand - - - - - Bartlesville

Top of Core - - - - - 2486.0

Bottom of Core - - - - - 2526.0

Top of Sand - - - (Cored) - - - 2486.0

Bottom of Sand - - - - - 2524.2

Total Feet of Permeable Sand - - - - - 36.3

Total Feet of Floodable Sand - - - - - 18.3

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 5	6.7	6.7
5 - 10	10.7	17.4
10 - 25	9.0	26.4
25 - 50	6.0	32.4
50 - 75	2.0	34.4
75 & above	1.9	36.3

Average Permeability Millidarcys - - - - - 20.5

Average Percent Porosity - - - - - 18.0

Average Percent Oil Saturation - - - - - 16.9

Average Percent Water Saturation - - - - - 63.2

Average Oil Content, Bbls./A. Ft. - - - - - 236.

Total Oil Content, Bbls./Acre - - - - - 8,820.

Average Percent Oil Recovery by Laboratory Flooding Tests - - - - - 4.6

Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft. - - - - - 67.

Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre - - - - - 1,096.

Total Calculated Oil Recovery, Bbls./Acre - (Primary & Secondary) - - - - - 3,790.

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 and sealed in tin cans by a representative of Oilfield Research Laboratories.

FORMATION CORED

The detailed log of the formation cored is as follows:

<u>Depth Interval, Feet</u>	<u>Description</u>
2486.0 - 2489.0	Grayish light brown fine grained micaceous slightly shaly sandstone.
2489.0 - 2489.3	Gray shaly sandstone.
2489.3 - 2492.0	Light brown fine grained micaceous slightly shaly sandstone.
2492.0 - 2492.7	Light brown fine grained micaceous shaly sandstone.
2492.7 - 2496.8	Light brown fine grained micaceous slightly shaly sandstone.
2496.8 - 2496.9	Gray sandy shale.
2496.9 - 2509.2	Light brown fine grained micaceous slightly shaly sandstone.
2509.2 - 2519.0	Light brown fine grained micaceous sandstone.
2519.0 - 2519.9	Light brown fine grained micaceous slightly shaly slightly carbonaceous sandstone.
2519.9 - 2520.7	Gray sandy shale.
2520.7 - 2524.2	Light brown fine grained micaceous sandstone.
2524.2 - 2526.0	Shale.

Coring was started at a depth of 2486.0 feet in grayish light brown fine grained micaceous slightly shaly sandstone and completed at 2526.0 feet in shale. This core shows a total of 37.3 feet

of sandstone. For the most part, the pay is made up of light brown fine grained micaceous slightly 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 3.5, 13.3 and 45.6 millidarcys respectively; the overall average being 20.5 (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 116 millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a low weighted average percent oil saturation, namely, 16.9. The weighted average percent oil saturation of the upper, middle and lower sections is 15.6, 16.0 and 19.8 respectively. The weighted average percent water saturation of the upper, middle and lower sections is 65.9, 63.5 and 60.8 respectively; the overall average being 63.2 (See Table III). This gives an overall weighted average total fluid saturation of 80.1 percent. This rather low 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 very little flushing of the sand occurred during coring as, for the most part, the more permeable sand does not have a much lower chloride content.

The weighted average oil content of the upper, middle and lower sections is 219, 225 and 273 barrels per acre foot respectively; the overall average being 236. The total oil content, as shown by this core is 8,820 barrels per acre. (See Table III).

LABORATORY FLOODING TESTS

When taking into consideration that the sand in the core has a low oil saturation, one would expect very little, if any, oil to be recovered from laboratory flooding tests, however, a total recovery of 1,096 barrels of oil per acre was obtained from 16.4 feet of sand. The weighted average percent oil saturation was reduced from 21.3 to 16.7, or represents an average recovery of 4.6 percent. The weighted average effective permeability of the samples is 1.54 millidarcys, while the average initial fluid production pressure is 20.6 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 37 samples tested, 36 produced water and 15 oil. This indicates that approximately 40 percent of the sand represented by these samples is floodable pay sand.

CONCLUSION

On the basis of the above data, we estimate that approximately 3,790 barrels of oil per acre or an average of 207 barrels a foot can be recovered from the area, represented by this core, by efficient primary and water flood operations. The following data and

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assumptions were used in calculating the above oil recovery value:

Present formation volume factor	1.23
Irreducible water saturation, percent	47.0
Primary recovery, estimated, percent	None
Present oil saturation, percent	43.1
Average porosity, percent	18.4
Oil saturation after flooding, percent	16.7
Performance factor, percent	55.0
Net floodable pay sand, feet	18.3

This core shows a rather clean sand section having a low oil saturation, a high water saturation and a fairly good porosity and permeability for its depth. Chances are, some oil was forced out of the core, during the removal of the core from the hole, by the expansion of gas carried in solution by the oil.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company Jackson Brothers Lease _____ Crew _____ Well No. 21

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	2486.1	16.3	20	69	89	253	2.9	0.6	0.6	152	1.73
2	2487.1	17.8	20	61	81	276	3.2	1.0	1.6	276	3.20
3	2488.1	16.7	18	68	86	233	2.3	1.4	3.0	386	3.22
4	2489.1	13.4	6	86	92	62	Imp.	0.3	3.3	19	0.00
5	2490.1	17.7	8	65	73	110	3.9	1.3	4.6	143	5.07
6	2491.1	18.5	20	63	83	287	4.9	1.4	6.0	402	6.86
7	2492.1	16.6	10	66	76	129	Imp.	0.7	6.7	90	0.00
8	2493.1	18.7	10	60	70	145	7.4	0.9	7.6	131	6.66
9	2494.1	19.3	19	60	79	285	7.5	1.0	8.6	285	7.50
10	2495.1	18.3	11	61	72	156	6.5	1.0	9.6	156	6.50
11	2496.1	18.3	7	63	70	99	9.1	1.2	10.8	119	10.82
12	2497.1	16.9	11	64	75	144	7.8	0.7	11.5	101	5.46
13	2498.1	18.5	23	61	84	330	9.3	1.0	12.5	330	9.30
14	2499.1	17.8	26	62	88	359	7.9	1.0	13.5	359	7.90
15	2500.1	18.5	20	62	82	287	13.	1.0	14.5	287	13.00
16	2501.1	17.7	17	65	82	233	9.9	1.0	15.5	233	9.90
17	2502.1	19.8	22	61	83	338	15.	1.0	16.5	338	15.00
18	2503.1	16.9	16	64	80	210	7.6	1.0	17.5	210	7.60
19	2504.1	15.9	21	67	88	259	3.9	1.0	18.5	259	3.90
20	2505.1	17.9	19	63	82	265	51.	1.0	19.5	265	51.00
21	2506.1	15.8	10	66	76	123	5.2	1.0	20.5	123	5.20
22	2507.1	18.4	15	63	78	214	28.	1.0	21.5	214	28.00
23	2508.1	18.9	21	60	81	308	16.	1.0	22.5	308	16.00
24	2509.1	16.8	10	67	77	130	16.	0.6	23.1	78	9.60

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company Jackson Brothers

Lease

Craw

Well No.

21

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.		
25	2510.1	17.8	17	64	81	235	17.	1.4	24.5	329	23.80
26	2511.1	17.6	11	68	79	150	22.	1.0	25.5	150	22.00
27	2512.1	19.2	19	61	80	283	16.	1.0	26.5	283	16.00
28	2513.1	18.3	8	73	81	114	32.	1.0	27.5	114	32.00
29	2514.1	17.9	18	58	76	249	28.	1.0	28.5	249	28.00
30	2515.1	18.8	26	56	82	379	15.	1.0	29.5	379	15.00
31	2516.1	17.9	28	55	83	389	116.	1.0	30.5	389	116.00
32	2517.1	16.9	9	65	74	118	22.	1.0	31.5	118	22.00
33	2518.1	16.9	15	74	89	118	37.	1.4	32.9	165	51.80
34	2519.1	17.6	22	57	79	300	9.1	0.9	33.8	270	8.19
35	2521.1	19.3	17	61	78	254	86.	0.9	34.7	229	77.40
36	2522.1	19.9	23	59	82	355	72.	1.0	35.7	355	72.00
37	2523.1	20.2	21	58	79	329	35.	1.6	37.3	526	56.00

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company	Jackson Brothers	Lease	Crew	Well No.	21	
Depth Interval, Feet	Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.		
Depth Interval, Feet	Feet of Core Analyzed	Average Porosity	Average Percent Oil Saturation	Average Percent Water Saturation	Average Oil Content Bbl./A. Ft.	Total Oil Content Bbls./Acre
2486.0 - 2492.7	5.7	3.5	20.08			
2492.7 - 2513.6	20.8	13.3	277.14			
2513.6 - 2524.2	9.8	45.6	446.39			
2486.0 - 2524.2	36.3	20.5	743.61			
2486.0 - 2492.7	6.7	17.2	15.6	65.9	219	1,468
2492.7 - 2513.6	20.8	18.0	16.0	63.5	225	4,672
2513.6 - 2524.2	9.8	18.4	19.8	60.8	273	2,680
2486.0 - 2524.2	37.3	18.0	16.9	63.2	236	8,820

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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	2486.1	16.8	17	222	0	0	17	222	4	0.20	50
2	2487.1	17.4	17	230	0	0	17	230	6	0.20	45
3	2488.1	16.4	15	191	0	0	15	191	6	0.20	45
4	2489.1	13.0	8	81	0	0	8	81	0	Imp.	-
5	2490.1	18.0	10	140	0	0	10	140	8	0.22	40
6	2491.1	18.6	20	288	3	43	17	245	15	0.40	35
7	2492.1	16.2	8	100	0	0	8	100	0	Imp.	-
8	2493.1	19.0	12	177	0	0	12	177	19	0.40	30
9	2494.1	19.0	19	280	3	44	16	236	24	0.50	30
10	2495.1	18.4	13	186	0	0	13	186	27	0.55	30
11	2496.1	18.7	9	130	0	0	9	130	29	0.67	30
12	2497.1	17.3	12	161	0	0	12	161	24	0.62	30
13	2498.1	18.8	23	335	7	102	16	233	48	1.00	20
14	2499.1	17.9	26	361	9	125	17	236	38	0.55	20
15	2500.1	18.8	20	291	4	58	16	233	58	1.00	20
16	2501.1	18.2	17	240	0	0	17	240	49	0.90	20
17	2502.1	19.4	22	331	7	105	15	226	70	1.20	20
18	2503.1	17.2	15	200	0	0	15	200	30	0.60	30
19	2504.1	16.1	18	225	0	0	18	225	16	0.33	35
20	2505.1	18.4	19	271	4	57	15	214	77	1.71	20
21	2506.1	16.2	11	151	0	0	12	151	21	0.44	30
22	2507.1	18.9	16	223	0	0	16	235	93	1.71	20
23	2508.1	18.9	21	308	5	73	16	235	77	1.71	20
24	2509.1	17.3	12	161	0	0	12	161	57	1.00	20

Company Jackson Brothers
Lease Crew
Well No. 21

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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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	Bbls./A. Ft.			
25	2510.1	17.4	17	230	1	14	16	75	216	32	0.78	30
26	2511.1	17.7	13	178	0	0	13	86	178	74	1.40	20
27	2512.1	18.7	19	276	4	58	15	75	218	48	1.00	20
28	2513.1	18.7	10	145	0	0	10	75	145	65	1.30	20
29	2514.1	18.3	18	255	2	28	16	70	227	68	1.66	20
30	2515.1	18.4	26	371	9	128	17	73	243	41	1.14	20
31	2516.1	17.9	28	389	12	167	16	77	222	184	5.60	10
32	2517.1	17.0	8	106	0	0	8	86	106	73	1.60	20
33	2518.1	17.2	16	213	0	0	16	84	213	90	2.20	10
34	2519.1	17.1	25	332	0	0	25	71	332	35	0.80	20
35	2521.1	19.2	19	283	0	0	19	73	283	76	2.50	10
36	2522.1	20.3	23	362	3	47	20	68	315	88	2.83	10
37	2523.1	20.4	21	333	1	16	20	64	317	82	2.33	10

Company Jackson Brothers Lease Crew Well No. 21

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	Lease	Crew	Well No.
Jackson Brothers	2490.6 - 2513.6	2513.6 - 2524.2	2490.6 - 2524.2
Depth Interval, Feet			21
Feet of Core Analyzed	10.8	5.6	16.4
Average Percent Porosity	18.5	19.2	18.8
Average Percent Original Oil Saturation	20.9	22.9	21.3
Average Percent Oil Recovery	4.5	4.9	4.6
Average Percent Residual Oil Saturation	16.4	18.0	16.7
Average Percent Residual Water Saturation	74.3	69.7	72.8
Average Percent Total Residual Fluid Saturation	90.7	87.7	89.5
Average Original Oil Content, Bbls./A. Ft.	294.	340.	310.
Average Oil Recovery, Bbls./A. Ft.	65.	70.	67.
Average Residual Oil Content, Bbls./A. Ft.	229.	270.	243.
Total Original Oil Content, Bbls./Acre	3,178.	1,908.	5,086.
Total Oil Recovery, Bbls./Acre	702.	394.	1,096.
Total Residual Oil Content, Bbls./Acre	2,476.	1,514.	3,990.
Average Effective Permeability, Millidarcys	0.95	2.67	1.54
Average Initial Fluid Production Pressure, p.s.i.	24.2	13.6	20.6

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 _____ Crew _____ Well No. 21

Sample No.	Depth, Feet	Chloride Content of Brine in Sand ppm	Percent Water Saturation		Total
			Connate	Drilling & Foreign	
1	2486.1	39,000			
2	2487.1	105,200			
3	2488.1	100,400			
4	2489.1	101,300			
5	2490.1	105,400			
6	2491.1	100,700			
7	2492.1	107,600			
8	2493.1	106,300			
9	2494.1	96,000			
10	2495.1	98,200			
11	2496.1	103,200			
12	2497.1	110,000			
13	2498.1	95,950			
14	2499.1	107,500			
15	2500.1	98,400			
16	2501.1	98,500			
17	2502.1	85,500			
18	2503.1	110,100			
19	2504.1	105,000			
20	2505.1	103,000			
21	2506.1	115,000			
22	2507.1	80,750			
23	2508.1	106,300			
24	2509.1	112,200			
25	2510.1	108,700			
26	2511.1	94,400			
27	2512.1	65,700			
28	2513.1	102,500			
29	2514.1	120,250			
30	2515.1	100,250			
31	2516.1	67,500			
32	2517.1	119,600			
33	2518.1	101,800			
34	2519.1	105,100			
35	2521.1	104,750			
36	2522.1	100,700			
37	2523.1	87,200			

Note: ppm — parts per million

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SUMMARY OF WATER DIFFERENTIATION TESTS

TABLE VII

Company Jackson Brothers Lease Crew Well No. 21

<u>Depth Interval, Feet</u>	<u>Chloride Content of Brine in Sand, ppm</u>	<u>Average Percent Connate Water</u>	<u>Average Percent Drilling & Foreign Water</u>
2486.0 - 2492.7	97,448		
2492.7 - 2513.6	99,940		
2513.6 - 2524.2	99,934		
2486.0 - 2524.2	99,491		

Note: ppm — parts per million.