OILFIELD RESEARCH LABORATORIES
536 NORTH HIGHLAND - CHANUTE, KANSAS - PHONE HE1-2650

December 28, 1967

Jackson Brothers
514 North Main
Eureka, Kansas 67045

Gentlemen:

Enclosed herewith is the report of the analysis of the Rotary core taken from the Hendrickson Lease, Well No. 5, Greenwood County, Kansas, and submitted to our laboratory on December 21, 1967.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Carl L. Pate

CLP:bjo

6 c. - Eureka, Kansas

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company Jackson Brothers Lease Hendrickson Well No. 5

Location SE, NE, NE

Section 17 Twp. 25S Rge. 9E County Greenwood State Kansas

Name of Sand	Bartlesville
Top of Core	2354.0
Bottom of Core	2405.0
Top of Pay Sand	2373.6
Bottom of Sand (Cored)	2405.0
Total Feet of Permeable Sand	39.4
Total Feet of Floodable Sand	17.3

Distribution of Permeable Sand: Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 1	7.2	7.2
1 - 3	9.1	16.3
3 - 5	7.8	24.1
5 - 7	4.9	29.0
7 - 10	4.4	33.4
10 & above	6.0	39.4

Average Permeability Millidarcys	3.9
Average Percent Porosity	16.6
Average Percent Oil Saturation	25.0
Average Percent Water Saturation	59.4
Average Oil Content, Bbls./A. Ft.	326.
Total Oil Content, Bbls./Acre	14,823.
Average Percent Oil Recovery by Laboratory Flooding Tests	6.0
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	83.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	934.
Total Calculated Oil Recovery, Bbls./Acre (Primary & Secondary)	3,305.
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 an employee of Oilfield Research Laboratories.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
2354.0 - 2354.7	Gray sandy shale.
2354.7 - 2360.5	Grayish light brown slightly shaly sandstone.
2360.5 - 2365.5	Gray shaly sandstone.
2365.5 - 2368.8	Gray slightly shaly sandstone.
2368.8 - 2370.3	Light brown slightly shaly sandstone.
2370.3 - 2371.0	Gray shaly sandstone.
2371.0 - 2390.5	Light brown slightly shaly sandstone.
2390.5 - 2405.0	Grayish light brown slightly shaly sandstone.

Coring was started at a depth of 2354.0 feet in gray sandy shale and completed at 2405.0 feet in grayish light brown slightly shaly sandstone. This core shows a total of 50.3 feet of sandstone. For the most part, the pay is made up of grayish brown to light brown 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 1.2, 4.5 and 8.7 millidarcys respectively; the overall average being 3.9 (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 Imp. to a maximum of 15.0 millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a fairly low weighted average percent oil saturation, namely, 25.0. The weighted average percent oil saturation of the upper, middle and lower sections is 18.8, 29.1 and 24.9 respectively. The weighted average percent water saturation of the upper, middle and lower sections is 71.5, 53.9 and 54.1 respectively; the overall average being 59.4 (See Table III). This gives an overall weighted average total fluid saturation of 84.4 percent.

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 the cutting of the core.

The weighted average oil content of the upper, middle and lower sections is 230, 384 and 337 barrels per acre foot respectively; the overall average being 326. The total oil content, as shown by this core, is 14,823 barrels per acre (See Table III).

LABORATORY FLOODING TESTS

The sand in this core did not respond very well to laboratory flooding tests, as a total recovery of 934 barrels of oil per acre was obtained from 11.3 feet of sand. The weighted average percent oil

saturation was reduced from 23.9 to 23.9, or represents an average recovery of 5.9 percent. The weighted average effective permeability of the samples is 0.38 millidarcys, while the average initial fluid production pressure is 39.9 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 43 samples tested, 17 produced water and 11 oil. This indicates that approximately 40 percent of the sand represented by these samples will take water. The tests also show that the sand extending from a depth of 2354.7 (top of sand) to 2373.6 feet is impermeable to water.

CONCLUSION

On the basis of the above data, we estimate that approximately 3,305 barrels of oil per acre or an average of 191 barrels per foot can be recovered from the area, represented by this core, by efficient primary and waterflood operations. The following data was used in calculating the above oil recovery value:

Present formation volume factor	1.22
Irreducible water saturation, percent	40.0
Primary recovery, estimated, percent	None
Present oil saturation, percent	49.2
Average porosity, percent	17.7
Oil saturation after flooding, percent	23.9
Performance factor	0.55
Net floodable pay sand, feet	17.3

This core shows a rather thick somewhat shaly sand section having a fairly low oil saturation, a rather high water saturation and a low permeability.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company Jackson Brothers Lease Hendrickson Well No. 5

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	2355.1	15.7	15	81	96	183	0.21	0.9	0.9	165	0.20
2	2356.1	16.1	23	60	83	287	0.57	1.0	1.9	287	0.57
3	2357.1	15.9	23	58	81	284	0.89	1.0	2.9	284	0.89
4	2358.1	15.0	21	77	98	244	Imp.	1.0	3.9	244	0.00
5	2359.1	15.3	2	85	87	24	Imp.	1.0	4.9	24	0.00
6	2360.1	16.3	16	79	95	202	Imp.	0.9	5.8	182	0.00
7	2362.1	13.3	20	76	96	206	Imp.	1.0	6.8	206	0.00
8	2364.1	8.2	17	80	97	108	Imp.	1.0	7.8	108	0.00
9	2366.1	16.3	12	79	91	152	Imp.	1.1	8.9	167	0.00
10	2367.1	16.6	11	80	91	142	0.42	1.0	9.9	142	0.42
11	2369.1	18.5	16	80	96	230	4.1	0.8	10.7	184	3.28
12	2370.1	18.8	32	49	81	467	0.87	0.7	11.4	327	0.61
13	2371.1	16.8	21	75	96	274	0.57	0.6	12.0	164	0.34
14	2372.1	17.6	30	49	79	410	2.2	1.0	13.0	410	2.20
15	2373.1	15.5	27	62	89	325	0.74	1.0	14.0	325	0.74
16	2374.1	17.7	29	49	78	398	6.6	1.0	15.0	398	6.60
17	2375.1	18.4	31	47	78	443	11.	1.0	16.0	443	11.00
18	2376.1	18.8	25	46	71	365	10.	1.0	17.0	365	10.00
19	2377.1	17.0	34	49	83	448	1.1	1.0	18.0	448	1.10
20	2378.1	15.5	20	61	81	241	1.6	1.0	19.0	241	1.60
21	2379.1	18.0	27	51	78	377	4.1	1.0	20.0	377	4.10
22	2380.1	18.1	33	48	81	463	3.5	1.0	21.0	463	3.50
23	2381.1	17.5	27	53	80	367	3.4	1.0	22.0	367	3.40
24	2382.1	15.9	33	60	93	407	5.1	1.0	23.0	407	5.10

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company Jackson Brothers Lease Hendrickson Well No. 5

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	2383.1	15.6	27	54	81	327	3.6	1.0	24.0	327	3.60
26	2384.1	16.3	27	53	80	342	4.1	1.0	25.0	342	4.10
27	2385.1	16.8	27	54	81	352	3.0	1.0	26.0	352	3.00
28	2386.1	17.2	29	53	82	387	3.1	1.0	27.0	387	3.10
29	2387.1	17.0	31	53	84	409	2.2	1.0	28.0	409	2.20
30	2388.1	16.0	31	57	88	385	1.6	1.0	29.0	385	1.60
31	2389.1	18.6	32	52	84	462	6.8	1.0	30.0	462	6.80
32	2390.1	17.7	29	52	81	398	5.4	0.9	30.9	358	4.86
33	2391.1	16.1	27	63	90	337	1.2	1.1	32.0	371	1.32
34	2392.1	14.6	29	65	94	329	0.35	1.0	33.0	329	0.35
35	2393.1	16.5	34	59	93	435	2.4	1.0	34.0	435	2.40
36	2394.1	17.8	38	44	82	525	9.4	1.0	35.0	525	9.40
37	2395.1	16.0	20	61	81	249	11.	1.0	36.0	249	11.00
38	2396.1	17.9	19	52	71	266	12.	1.0	37.0	266	12.00
39	2397.1	18.4	21	51	72	300	14.	1.0	38.0	300	14.00
40	2398.1	16.6	23	56	79	296	2.5	1.0	39.0	296	2.50
41	2399.1	17.9	24	53	77	334	15.	1.0	40.0	334	15.00
42	2400.1	17.8	21	53	74	290	6.7	1.0	41.0	290	6.70
43	2401.1	17.8	25	53	78	346	9.2	1.0	42.0	346	9.20
44	2402.1	16.0	26	59	85	324	1.1	1.0	43.0	324	1.10
45	2403.1	15.9	29	57	86	358	8.7	1.0	44.0	358	8.70
46	2404.1	18.1	33	53	86	464	8.9	1.4	45.4	650	12.47

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company Jackson Brothers Lease Hendrickson Well No. 5

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
2354.7 - 2373.6	8.0	1.2	9.25
2373.6 - 2395.6	22.0	4.5	100.13
2395.6 - 2405.0	9.4	8.7	81.67
2354.7 - 2405.0	39.4	3.9	191.05

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
2354.7 - 2373.6	14.0	15.6	18.8	71.5	230.	3,219.
2373.6 - 2395.6	22.0	16.9	29.1	53.9	384.	8,440.
2395.6 - 2405.0	9.4	17.4	24.9	54.1	337.	3,164.
2354.7 - 2405.0	45.4	16.6	25.0	59.4	326.	14,823.

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company Jackson Brothers Lease Hendrickson Well No. 5

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	2355.1	15.4	17	203	0	0	17	80	203	0	Imp.	-
2	2356.1	15.8	20	245	0	0	20	67	245	0	Imp.	-
3	2357.1	15.7	20	244	0	0	20	66	244	0	Imp.	-
4	2358.1	15.4	19	227	0	0	19	79	227	0	Imp.	-
5	2359.1	15.6	4	48	0	0	4	86	48	0	Imp.	-
9	2366.1	16.0	14	174	0	0	14	82	174	0	Imp.	-
10	2367.1	16.1	13	162	0	0	13	82	162	0	Imp.	-
11	2369.1	18.0	14	195	0	0	14	84	195	0	Imp.	-
12	2370.1	18.4	29	414	0	0	29	57	414	0	Imp.	-
13	2371.1	16.4	19	242	0	0	19	79	242	0	Imp.	-
14	2372.1	17.3	27	362	0	0	27	57	362	0	Imp.	-
15	2373.1	15.9	25	308	0	0	25	68	308	0	Imp.	-
16	2374.1	17.6	29	396	3	41	26	60	355	3	0.20	50
17	2375.1	18.0	31	432	9	126	22	63	306	12	0.40	40
18	2376.1	18.5	25	359	5	72	20	68	287	12	0.30	40
19	2377.1	16.7	31	402	0	0	31	56	402	0	Imp.	-
20	2378.1	15.9	18	222	0	0	18	68	222	0	Imp.	-
21	2379.1	17.5	24	326	0	0	24	58	326	0	Imp.	-
22	2380.1	17.7	30	412	0	0	30	55	412	0	Imp.	-
23	2381.1	17.2	25	334	0	0	25	63	334	2	0.10	50
24	2382.1	16.3	33	417	6	76	27	70	341	4	0.20	50
25	2383.1	16.0	24	298	0	0	24	60	298	0	Imp.	-
26	2384.1	15.9	25	308	0	0	25	60	308	0	Imp.	-
27	2385.1	16.3	25	316	0	0	25	59	316	0	Imp.	-

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

Company Jackson Brothers Lease Hendrickson Well No. 5

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.			
28	2386.1	16.8	26	339	0	0	26	60	339	0	Imp.	-
29	2387.1	16.6	28	361	0	0	28	60	361	0	Imp.	-
30	2388.1	16.3	28	354	0	0	28	64	354	0	Imp.	-
31	2389.1	18.2	32	452	6	85	26	62	367	3	0.20	50
32	2390.1	17.9	29	403	2	28	27	60	375	4	0.20	50
33	2391.1	15.8	25	306	0	0	25	69	306	0	Imp.	-
34	2392.1	15.0	26	303	0	0	26	70	303	0	Imp.	-
35	2393.1	16.1	31	387	0	0	31	64	387	0	Imp.	-
36	2394.1	17.4	38	513	14	189	24	65	324	13	0.40	40
37	2395.1	15.7	23	280	0	0	23	62	280	0	Imp.	-
38	2396.1	17.6	20	273	0	0	20	63	273	11	0.30	40
39	2397.1	18.0	18	251	0	0	18	65	251	10	0.40	40
40	2398.1	17.0	22	290	0	0	22	69	290	12	0.40	40
41	2399.1	18.3	24	341	3	43	21	65	298	24	0.60	30
42	2400.1	17.9	21	292	0	0	21	68	292	17	0.40	30
43	2401.1	17.4	25	337	3	40	22	74	297	22	0.60	30
44	2402.1	15.5	25	301	0	0	25	67	301	2	0.10	50
45	2403.1	16.4	29	369	6	76	23	63	293	18	0.50	20
46	2404.1	18.5	33	474	8	115	25	64	359	16	0.50	40

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 Lease Hendrickson Well No. 5

Depth Interval, Feet	2373.6 - 2395.6	2395.6 - 2405.0	2373.6 - 2405.0
Feet of Core Analyzed	6.9	4.4	11.3
Average Percent Porosity	17.7	17.7	17.7
Average Percent Original Oil Saturation	31.0	28.3	29.9
Average Percent Oil Recovery	6.5	5.3	6.0
Average Percent Residual Oil Saturation	24.5	23.0	23.9
Average Percent Residual Water Saturation	64.0	66.3	64.9
Average Percent Total Residual Fluid Saturation	88.5	89.3	88.8
Average Original Oil Content, Bbls./A. Ft.	425.	389.	411.
Average Oil Recovery, Bbls./A. Ft.	89.	73.	83.
Average Residual Oil Content, Bbls./A. Ft.	336.	316.	328.
Total Original Oil Content, Bbls./Acre	2,931.	1,711.	4,642.
Total Oil Recovery, Bbls./Acre	614.	320.	934.
Total Residual Oil Content, Bbls./Acre	2,317.	1,391.	3,708.
Average Effective Permeability, Millidarcys	0.27	0.55	0.38
Average Initial Fluid Production Pressure, p.s.i.	45.7	30.9	39.9

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 Hendrickson Well No. 5

Sample No.	Depth, Feet	Chloride Content of Brine in Sand ppm	Percent Water Saturation Connate	Drilling & Foreign	Total
1	2355.1	98,750			
2	2356.1	103,800			
3	2357.1	99,600			
4	2358.1	95,800			
5	2359.1	99,650			
6	2360.1	100,750			
7	2362.1	90,750			
8	2364.1	70,300			
9	2366.1	91,000			
10	2367.1	102,250			
11	2369.1	100,300			
12	2370.1	96,450			
13	2471.1	102,000			
14	2372.1	103,500			
15	2373.1	99,600			
16	2374.1	103,100			
17	2375.1	84,700			
18	2376.1	97,450			
19	2377.1	99,200			
20	2378.1	101,500			
21	2379.1	103,800			
22	2380.1	103,250			
23	2381.1	96,100			
24	2482.1	105,300			
25	2383.1	104,900			
26	2384.1	101,300			
27	2385.1	104,200			
28	2386.1	100,500			
29	2387.1	99,200			
30	2388.1	100,800			
31	2389.1	96,600			
32	2390.1	97,800			
33	2391.1	90,400			

Note: ppm — parts per million

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RESULTS OF WATER DIFFERENTIATION TESTS

TABLE VI

Company Jackson Brothers Lease Hendrickson Well No. 5

Sample No.	Depth, Feet	Chloride Content of Brine in Sand ppm	Percent Water Saturation		
			Connate	Drilling & Foreign	Total
34	2392.1	107,600			
35	2393.1	98,550			
36	2394.1	104,500			
37	2395.1	90,350			
38	2396.1	113,850			
39	2397.1	108,200			
40	2398.1	106,800			
41	2399.1	99,500			
42	2400.1	98,550			
43	2401.1	94,700			
44	2402.1	97,800			
45	2403.1	106,200			
46	2404.1	99,800			

Note: ppm — parts per million

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SUMMARY OF WATER DIFFERENTIATION TESTS

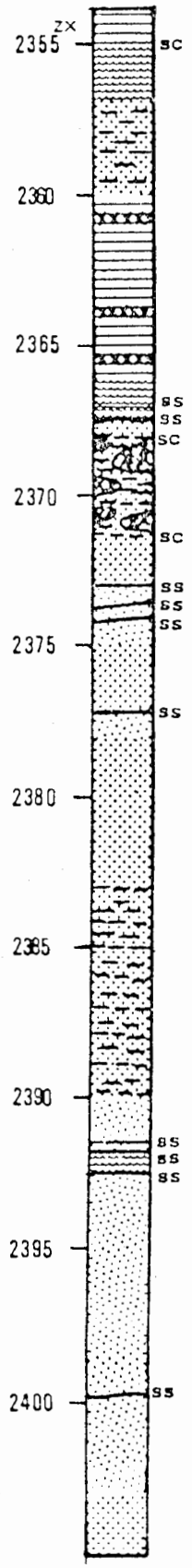
TABLE VII

Company Jackson Brothers Lease Hendrickson Well No. 5

Depth Interval, Feet	Chloride Content of Brine in Sand, ppm	Average Percent Connate Water	Average Percent Drilling & Foreign Water
2354.7 - 2373.6	96,211		
2373.6 - 2395.6	99,559		
2395.6 - 2405.0	102,691		
2354.7 - 2405.0	99,175		

Note: ppm — parts per million.

JACKSON BROS. HENDRICKSON NO. 5 17-25S-9E



light gray laminated siltstone

small scale unidirectional asymmetrical current ripples

horizontal laminae outlined by discontinuous silt wisps

light gray interlaminated siltstone and sandstone with contorted bedding, iron claystone layers, and multidirectional ripple bedding

silty sandstone with small scale ripples and low angle inclined laminations

contorted siltstone conglomerate zone

generally a massive sandstone with faint horizontal laminae or low angle inclined planar laminae

horizontal laminae

large scale inclined planar bedding

small scale asymmetrical unidirectional current ripples

large scale inclined planar laminae

massive bedding