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

November 2, 1968

King Resources Company
100 Park Avenue Building Suite 333
Oklahoma City, Oklahoma 73102

Gentlemen:

Enclosed herewith is the report of the analysis of the Rotary core taken from the Engstrom Lease, Well No. CT-1, Wilson County, Kansas, and submitted to our laboratory on October 28, 1968.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Carl L. Pate

CLP:dp

6 c. - Oklahoma City, Oklahoma

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company King Resources Company Lease Engstrom Well No. CT-1

Location 660' SNL & 1100' WEL, NW/4

Section 27 Twp. 28S Rge. 14E County Wilson State Kansas

Name of Sand	New Albany
Top of Core	281.0
Bottom of Core	318.0
Top of oil Sand	285.5
Bottom of oil Sand	305.6
Total Feet of Permeable Sand (Analyzed)	22.4
Total Feet of Floodable Pay Sand	12.3

Distribution of Permeable Sand: Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 75	3.4	3.4
75 - 100	4.8	8.2
100 - 150	10.5	18.7
150 & above	3.7	22.4

Average Permeability Millidarcys	116.2
Average Percent Porosity	24.0
Average Percent Oil Saturation	29.1
Average Percent Water Saturation	50.8
Average Oil Content, Bbls./A. Ft.	567.
Total Oil Content, Bbls./Acre	12,690.
Average Percent Oil Recovery by Laboratory Flooding Tests	3.7
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	70.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	994.
Total Calculated Oil Recovery, Bbls./Acre (Primary & Secondary)	3,310.
~~Packer Setting~~ Casing Point, Feet	287'
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 plastic bags by a representative of Oilfield Research Laboratories.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
281.0 - 281.5	Loss.
281.5 - 285.5	Gray finely laminated shaly sandstone.
285.5 - 287.0	Brown fine grained micaceous sandstone.
287.0 - 289.0	Brown fine grained micaceous sandstone with a few gray laminations.
289.0 - 297.0	Brown fine grained micaceous sandstone containing a vertical fracture.
297.0 - 298.2	Light brown fine grained micaceous sandstone.
298.2 - 302.0	Brown fine grained micaceous sandstone.
302.0 - 303.0	Gray fine grained micaceous sandstone.
303.0 - 303.3	Light brown fine grained micaceous sandstone.
303.3 - 303.8	Gray fine grained micaceous sandstone.
303.8 - 305.6	Brown fine grained micaceous sandstone.
305.6 - 311.2	Gray fine grained micaceous sandstone.
311.2 - 317.0	Gray sandy shale.
317.0 - 318.0	Dark shale.

Coring was started at a depth of 281.0 feet; in probably gray finely laminated shaly sandstone and completed at 318.0 feet in dark shale.

There was a core loss of 0.5 feet at top of core. This core shows a total of 29.7 feet of sandstone. For the most part, the pay is made up of brown fine grained micaceous 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 120.3 and 104.4 millidarcys respectively; the overall average being 116.2 (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has a comparatively uniform permeability profile. The permeability of the sand varies from 31. to a maximum of 181. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a fairly low weighted average percent oil saturation, namely, 29.1. The weighted average percent oil saturation of the upper and lower sections is 35.6 and 14.2 respectively. The weighted average percent water saturation of the upper and lower sections is 41.5 and 76.6 respectively; the overall average being 50.8 (See Table III). This gives an overall weighted average total fluid saturation of 79.9 percent. This fairly low total fluid saturation indicates some fluid was lost during coring which was probably oil.

The tests show the pay sand section extends from a depth of 285.5 to 302.0 feet (upper section).

The weighted average oil content of the upper and lower sections is 678 and 256 barrels per acre foot respectively; the overall average being 567. The total oil content, as shown by this core, is 12,690 barrels per acre of which 11,180 barrels are in the pay sand 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 994 barrels of oil per acre was obtained from 14.1 feet of sand. The weighted average percent oil saturation was reduced from 36.7 to 33.0, or represents an average recovery of 3.7 percent. The weighted average effective permeability of the samples is 6.21 millidarcys, while the average initial fluid production pressure is 10.7 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 22 samples tested, all produced water and oil. This indicates that approximately 64 percent of the sand represented by these samples is floodable pay sand. In order to determine whether there is any vertical effective permeability between the oil and water sands, two samples were analyzed (See Table IV). The tests show that the average horizontal effective permeability is approximately 9 times that of the vertical permeability.

CONCLUSION

On the basis of the above data, we estimate that approximately 3,310 barrels of oil per acre or an average of 269 barrels per acre foot can be recovered from the area, represented by this core, by efficient waterflood operations provided the injected water can be confined to the pay zone. The following data and assumptions were used in calculating the above oil recovery value:

Present formation volume factor	1.02
Irreducible water saturation, percent	37.0

Primary recovery, percent	None
Present oil saturation, percent	61.8
Average porosity, percent	24.8
Oil saturation after flooding, percent	33.8
Performance factor, percent	50.0
Net floodable pay sand, feet	12.3

This core shows a clean pay sand section (285.5 to 302.0 feet) having a fair oil saturation, a moderate water saturation and a good porosity and permeability. Before this well is placed on production, we recommend the hold be plugged back to a depth of 301 feet.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company King Resources Company Lease Engstrom Well No. CT-1

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	286.5	20.0	42	39	81	652	67	1.5	1.5	978	99.90
2	287.7	24.7	27	49	76	518	86	1.1	2.6	570	94.60
3	288.6	23.6	28	56	84	513	31	0.9	3.5	462	27.90
4	289.6	24.0	36	44	80	670	101	1.1	4.6	737	111.15
5	290.6	26.7	45	37	82	932	135	1.1	5.7	1026	148.50
6	291.8	26.0	40	39	79	807	84	1.0	6.7	807	84.00
7	292.6	25.1	34	41	75	662	181	0.9	7.6	596	162.90
8	293.6	23.4	35	43	78	635	143	0.9	8.5	572	128.75
9	294.4	24.9	36	39	75	696	118	1.0	9.5	696	118.00
10	295.5	25.5	36	40	76	712	169	1.0	10.5	712	169.00
11	296.6	25.9	40	38	78	804	145	1.0	11.5	804	145.00
12	297.6	26.3	35	42	77	714	88	1.2	12.7	857	105.60
13	298.4	26.0	35	38	73	706	166	0.7	13.4	494	116.20
14	299.3	25.1	34	37	71	662	145	1.0	14.4	662	145.00
15	300.6	21.9	28	41	69	476	181	1.1	15.5	524	199.10
16	301.5	25.9	34	43	77	683	130	1.0	16.5	683	130.00
17	302.5	24.6	7	91	98	134	89	1.0	17.5	134	89.00
18	303.6	25.6	10	83	93	199	81	0.5	18.0	99	40.50
19	304.5	26.1	29	47	76	588	149	1.2	19.2	706	178.80
20	305.5	21.1	32	49	81	524	119	0.6	19.8	314	71.40
21	306.5	20.9	3	93	96	49	109	1.6	21.4	78	174.50
22	307.8	17.7	13	85	98	179	62	1.0	22.4	179	62.00

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company King Resources Company Lease Engstrom Well No. CT-1

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
285.5 - 302.0	16.5	120.3	1,985.60
302.0 - 308.2	5.9	104.4	616.20
285.5 - 308.2	22.4	116.2	2,601.80

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
285.5 - 302.0	16.5	24.5	35.6	41.5	678	11,180
302.0 - 308.2	5.9	22.5	14.2	76.6	256	1,510
285.5 - 308.2	22.4	24.0	29.1	50.8	567	12,690

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company King Resources Company Lease Engstrom Well No. CT-1

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	286.5	19.5	42	636	6	91	36	53	545	49	1.70	15
2	287.7	25.1	29	565	0	0	29	64	565	111	3.30	10
3	288.6	24.0	26	484	0	0	26	65	484	88	2.70	10
4	289.6	23.7	36	662	2	37	34	63	625	79	2.60	10
5	290.6	27.0	45	942	10	209	35	63	733	126	5.30	10
6	291.8	25.6	40	795	3	60	37	63	735	66	2.40	15
7	292.6	24.6	34	649	1	19	33	60	630	107	3.20	10
8	293.6	23.8	35	646	2	37	33	62	609	127	4.00	10
9	294.4	24.9	36	696	3	58	33	57	638	106	3.40	10
10	295.5	25.8	36	721	2	40	34	58	681	112	3.40	10
11	296.6	25.8	40	800	10	200	30	70	600	131	5.00	10
12	297.6	26.1	35	708	2	40	33	66	668	197	9.00	10
13	298.4	26.6	35	722	2	41	33	66	681	235	9.20	10
14	299.3	25.5	34	673	2	40	32	67	633	241	10.40	10
15	300.6	22.2	30	517	0	0	30	67	517	222	11.20	10
16	301.5	25.5	32	633	0	0	32	62	633	251	18.65	10
17	302.5	25.0	9	175	0	0	9	90	175	170	20.00	10
18	303.6	25.3	8	157	0	0	8	92	157	186	51.95	5
19	304.5	26.0	29	585	2	40	27	70	545	278	17.47	10
20	305.5	29.8	32	516	2	32	30	69	484	367	12.60	10
21	306.5	21.3	5	83	0	0	5	93	83	302	30.22	5
22	307.8	17.8	9	124	0	0	9	89	124	364	20.20	5
V-1	302.5	-	-	-	-	-	-	-	-	61	2.92	10
V-2	303.6	-	-	-	-	-	-	-	-	76	5.64	10

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.

Note: V - Vertical Effective Permeability Samples

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SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company King Resources Company Lease Engstrom Well No. CT-1

Depth Interval, Feet	285.5 - 302.0	302.0 - 318.2	285.5 - 318.2
Feet of Core Analyzed	12.3	1.8	14.1
Average Percent Porosity	24.8	24.4	24.7
Average Percent Original Oil Saturation	37.7	30.0	36.7
Average Percent Oil Recovery	3.9	2.0	3.7
Average Percent Residual Oil Saturation	33.8	28.0	33.0
Average Percent Residual Water Saturation	62.4	69.7	63.2
Average Percent Total Residual Fluid Saturation	96.2	97.7	96.2
Average Original Oil Content, Bbls./A. Ft.	722.	561.	702.
Average Oil Recovery, Bbls./A. Ft.	75.	37.	70.
Average Residual Oil Content, Bbls./A. Ft.	647.	524.	632.
Total Original Oil Content, Bbls./Acre	8885.	1011.	9896.
Total Oil Recovery, Bbls./Acre	927.	67.	994.
Total Residual Oil Content, Bbls./Acre	7958.	944.	8902.
Average Effective Permeability, Millidarcys	4.79	15.85	6.21
Average Initial Fluid Production Pressure, p.s.i.	10.8	10.	10.7

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

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

October 22, 1968

King Resources Company
100 Park Avenue Building
Suite 333
Oklahoma City, Oklahoma 73100

Attention: Mr. Kenneth P. Huffman

Gentlemen:

Attached hereto is a log of the core taken from the Engstrom Well No. CT1, located in the northwest quarter, S27, Twp28S, R14E, Wilson County, Kansas.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Carl L. Pate

CLP:dp

5 c. - Oklahoma City, Oklahoma

OILFIELD RESEARCH LABORATORIES

-LOG OF CORE-

Company King Resources Company Lease Engstrom Well No. CT1

Depth Interval, Feet	Description
249.0 - 259.0	Grayish light brown sandy limestone, (show of oil).
259.0 - 261.2	Gray sandy limestone.
261.2 - 269.5	Gray shaly sandy limestone.
269.5 - 275.0	Gray laminated slightly calcareous sandy shale.