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

OILFIELD RESEARCH LABORATORIES

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May 12, 1961

Paw-Cat Associates
1742 South Minnesota
Wichita 11, Kansas

Gentlemen:

Enclosed herewith is the report of the analysis of the Cable Tool core taken from the Brady Lease, Well No. 4, Franklin County, Kansas, and submitted to our laboratory on May 6, 1961.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Benjamin R. Pearman

Benjamin R. Pearman

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GENERAL INFORMATION & SUMMARY

Company Paw-Cat Associates Lease Brady Well No. 4

Location NW

Section 29 Twp. 15S Rge. 20E County Franklin State Kansas

Name of Sand	Squirrel
Top of Core	756.4
Bottom of Core	782.3
Top of Sand	756.4
Bottom of Sand	779.0
Total Feet of Permeable Sand	19.5
Total Feet of Floodable Sand	10.5

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 50	7.1	7.1
50 - 100	10.4	17.5
100 & above	2.0	19.5

Average Permeability Millidarcys	65.4
Average Percent Porosity	22.0
Average Percent Oil Saturation	32.4
Average Percent Water Saturation	53.9
Average Oil Content, Bbls./A. Ft.	552.
Total Oil Content, Bbls./Acre	12,370.
Average Percent Oil Recovery by Laboratory Flooding Tests	3.3
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	55.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	577.
Total Calculated Oil Recovery, Bbls./Acre	1,860.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

This core was taken with a cable tool core barrel using fresh water as the coring fluid. The well was drilled in non-virgin territory. The core was sampled and the samples sealed in cans by a representative of Oilfield Research Laboratories.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
737.8 - 744.6	Shale discarded.
744.6 - 756.4	Drilled.
756.4 - 757.2	Brown sandstone.
757.2 - 757.4	Gray and light brown shaley sandstone.
757.4 - 763.0	Brown sandstone.
763.0 - 763.9	Brown and gray finely laminated shaley sandstone.
763.9 - 779.0	Soft brown slightly laminated shaley sandstone.
779.0 - 779.3	Shale.
779.3 - 779.6	Shaley limestone.
779.6 - 782.3	Shale.

Coring was started at a depth of 756.4 feet in brown sandstone and completed at 782.3 feet in shale. This core shows a total of 22.4 fee of sandstone. For the most part, the pay is made up of brown, slightly laminated 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 66.2 and 61.3 millidarcys respectively; the overall average being 65.4 (See Table III). By observing the data given on the core-graph, it is noticeable that the sand has a fairly uniform permeability profile. The permeability of the sand varies from 23 to a maximum of 121 millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a fair weighted average percent oil saturation, namely, 32.4. The weighted average percent oil saturation of the upper and lower sections is 33.8 and 25.6 respectively. The weighted average percent water saturation of the upper and lower sections is 52.5 and 59.8 respectively; the overall average being 53.9 (See Table III). This gives an overall weighted average total fluid saturation of 86.3 percent.

The weighted average oil content of the upper and lower sections is 579 and 441 barrels per acre foot respectively; the overall average being 552. The total oil content, as shown by this core, is 12,370 barrels per acre (See Table III).

LABORATORY FLOODING TESTS

Because of the soft nature of the sand in this core, it was possible to obtain only 15 samples for laboratory flooding tests.

This portion of the core responded rather poorly to laboratory flooding tests, as a total recovery of 577 barrels of oil per acre was obtained from 10.5 feet of sand. The weighted average percent oil saturation was reduced from 35.7 to 32.4, or represents an average recovery of 3.3 percent. The weighted average effective permeability of the samples is 2.18 millidarcys, while the average initial fluid production pressure is 28.2 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 15 samples tested, all produced water and 11 oil. This indicates that approximately 73 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sand has a wide variation in effective permeability to water.

CONCLUSION

Based on the results of the laboratory tests, it appears that an efficient water flood in the vicinity of this well should recover ap-

proximately 1,860 barrels of oil per acre. This represents an average recovery of 177 barrels of oil per acre foot from the 10.5 feet of floodable pay sand analyzed in this core. This calculated recovery is a minimum value. Because of the soft nature of the sand, it was impossible to obtain sufficient samples to test the entire core. Based on the results of the saturation tests it appears that at least an additional five feet of floodable sand exists in the core. Including these five feet the calculated recovery would be approximately 2,740 barrels per acre.

The above recovery values were calculated using the following data and assumptions:

Original formation volume factor	1.04
Present formation volume factor	1.02
Reservoir water saturation, percent	40.0
Primary recovery, percent estimated	7.0
Average porosity, percent	21.8
Abandonment oil saturation, percent	32.4
Performance factor, percent	55.0
Net floodable pay sand analyzed, feet	10.5

This core indicates a clean sand section having a fair oil saturation, a somewhat high water saturation and a rather wide variation in effective permeability to water.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company Paw-Cat Associates **Lease** Brady **Well No.** 4

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	756.5	20.8	37	53	90	596	51.	0.8	0.8	476	40.80
2	757.6	22.1	37	54	91	634	97.	0.6	1.4	380	58.20
3	758.5	21.4	34	49	83	564	121.	1.0	2.4	564	121.00
4	759.5	22.1	37	48	85	634	98.	1.0	3.4	634	98.00
5	760.5	21.3	33	51	84	545	30.	1.0	4.4	545	30.00
6	761.5	23.0	35	51	86	624	108.	1.0	5.4	624	108.00
7	762.5	23.4	32	53	85	580	-	1.0	6.4	580	-
8	763.5	19.3	27	66	93	404	-	0.9	7.3	364	-
9	764.5	23.4	35	49	84	635	49.	1.1	8.4	699	53.90
10	765.5	22.8	37	51	88	654	87.	1.0	9.4	654	87.00
11	766.5	23.0	34	54	88	606	81.	1.0	10.4	606	81.00
12	767.5	22.2	28	51	79	482	77.	1.0	11.4	482	77.00
13	768.5	21.2	31	57	88	509	72.	1.0	12.4	509	72.00
14	769.5	22.4	39	51	90	677	53.	1.0	13.4	677	53.00
15	770.5	22.6	33	54	87	578	36.	1.0	14.4	578	36.00
16	771.5	20.4	39	52	91	616	27.	1.0	15.4	616	27.00
17	772.5	20.6	29	47	76	463	23.	1.0	16.4	463	23.00
18	773.5	22.0	37	52	89	631	66.	1.0	17.4	631	66.00
19	774.5	21.8	31	57	88	524	59.	1.0	18.4	524	59.00
20	775.5	20.4	26	60	86	411	-	1.0	19.4	411	-
21	776.5	23.0	25	60	85	446	88.	1.0	20.4	446	88.00
22	777.5	22.5	25	53	78	436	47.	1.0	21.4	436	47.00
23	778.5	23.4	26	66	92	471	49.	1.0	22.4	471	49.00

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company Paw-Cat Associates Lease Brady Well No. 4

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
756.4 - 775.0	16.5	66.2	1090.90
775.0 - 779.0	3.0	61.3	184.00
756.4 - 779.0	19.5	65.4	1274.90

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
756.4 - 775.0	18.4	21.9	33.8	52.5	579	10,606
775.0 - 779.0	4.0	22.4	25.6	59.8	441	1,764
756.4 - 779.0	22.4	22.0	32.4	53.9	552	12,370

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company Paw-Cat Associates Lease Brady Well No. 4

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	756.5	20.6	37	590	3	48	34	55	542	30	1.80	30
2-A	757.8	22.2	38	654	3	52	35	58	602	2	0.260	50
3	758.5	21.0	34	554	2	33	32	55	521	13	0.387	30
4	759.5	22.5	37	645	6	105	31	60	540	44	2.73	30
5	760.5	21.3	33	545	2	33	31	58	512	8	0.288	35
9-A	764.3	23.0	35	624	2	36	33	55	588	5	0.133	35
14	769.5	22.5	39	680	5	87	34	60	593	72	4.25	25
15	770.5	22.2	33	568	2	34	31	62	534	62	2.63	20
16	771.5	19.9	39	601	7	108	32	61	493	63	2.21	20
17	772.5	20.2	28	439	0	0	28	52	439	7	0.298	30
18	773.5	21.8	37	625	3	51	34	60	574	47	1.60	20
19	774.5	21.8	31	524	1	17	30	68	507	303	7.14	15
21	776.5	22.7	26	458	0	0	26	70	458	259	10.95	15
22	777.5	22.6	25	438	0	0	25	69	438	172	9.92	15
23	778.5	23.1	24	430	0	0	24	69	430	190	5.04	15

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 Paw-Cat Associates Lease Brady Well No. 4

Depth Interval, Feet	756.4 - 775.0
Feet of Core Analyzed	10.5
Average Percent Porosity	21.8
Average Percent Original Oil Saturation	35.7
Average Percent Oil Recovery	3.3
Average Percent Residual Oil Saturation	32.4
Average Percent Residual Water Saturation	59.4
Average Percent Total Residual Fluid Saturation	91.8
Average Original Oil Content, Bbls./A. Ft.	600.
Average Oil Recovery, Bbls./A. Ft.	55.
Average Residual Oil Content, Bbls./A. Ft.	545.
Total Original Oil Content, Bbls./Acre	6,292.
Total Oil Recovery, Bbls./Acre	577.
Total Residual Oil Content, Bbls./Acre	5,715.
Average Effective Permeability, Millidarcys	2.18
Average Initial Fluid Production Pressure, p.s.i.	28.2

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