March 31, 1950

Deep Rock Oil Corporation
Tulsa, Oklahoma

Attention: Mr. T. F. Lawry

Gentlemen:

Enclosed herewith is a report of the analysis made on the 2½ inch rotary core taken from the Engel # 3 Lease, Core Test Well No. 1, Crawford County, Kansas, and submitted to our laboratory on March 27, 1950.

Very truly yours,

OIL FIELD RESEARCH LABORATORIES

Carl L. Pate

CLP:dt
c.c. to Mr. Neil Henderson

DEEP ROCK OIL CORPORATION

CORE ANALYSIS REPORT

HOEL & S LEASE CORE TEST WELL NO. 1

CRAWFORD COUNTY, KANSAS

OIL FIELD RESEARCH LABORATORIES

CHANUTE, KANSAS

MARCH 31, 1950

Oil Field Research Laboratories

GENERAL INFORMATION & SUMMARY

Company Deep Rock Oil Corporation Lease Engel # 3 Core Test Well No. 1

Location 400 ft. north of south line and 400 ft. east of west line, NE¼,

Section 28 Twp. 28S Rge. 22E County Crawford State Kansas

Name of Sand	Bartlesville
Top of Core	366.27
Bottom of Core	394.50
Top of Sand	?
Bottom of pay Sand	382.27
Total Feet of Permeable Sand	21.02

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 5	4.57	4.57
5 - 10	5.42	9.99
10 - 20	5.75	15.74
20 - 30	3.07	18.81
30 - 40	1.18	19.99
40 - 50	0.13	20.12
50 & above	0.90	21.02

Average Permeability, Millidarcys	14.17
Average Percent Porosity	17.07
Average Percent Oil Saturation	48.53
Average Percent Water Saturation	34.35
Average Oil Content, Bbls./A. Ft.	649.
Total Oil Content, Bbls./Acre	13,077.
Average Percent Oil Recovery by Laboratory Flooding Tests	8.99
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	127.
Aotal Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	1,484.
Total Calculated Oil Recovery, Bbls./Acre	1,800.
Packer Setting, Feet	365.0
Viscosity, Centipoises @ 67° F.	34.8
A. P. I. Gravity, degrees @ 60 °F	28.3

Note: The above averages are for that part of the sand section extending from the top of the core to the top of the cement plug.

Fresh water was used as a circulating fluid in the coring of the sand in this well.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, feet	Description
366.27 - 368.20	Brown fine grained micaceous sandstone.
368.20 - 368.43	Gray shale.
368.43 - 373.95	Brown fine grained micaceous slightly shaley sandstone.
373.95 - 376.92	Brown fine grained micaceous carbonaceous shaley sandstone.
376.92 - 377.80	Brown fine grained micaceous sandstone.
377.80 - 377.90	Shale.
377.90 - 379.00	Brown fine grained micaceous sandstone.
379.00 - 379.15	Gray shale.
379.15 - 380.90	Brown fine grained micaceous carbonaceous sandstone.
380.90 - 381.10	Brown fine grained micaceous sandstone.
381.10 - 381.50	Gray finely laminated sandy shale.
381.50 - 382.27	Brown fine grained micaceous shaley sandstone.
382.27 - 384.30	Hard gray limestone.
384.30 - 387.35	Dark fine grained micaceous carbonaceous sandstone.
387.35 - 388.40	Brown fine grained micaceous carbonaceous shaley sandstone.
388.40 - 389.05	Gray shale.
389.05 - 390.20	Dark fine grained micaceous carbonaceous sandstone.
390.20 - 390.60	Laminated sandstone and shale.
390.60 - 392.10	Dark fine grained micaceous carbonaceous shaley sandstone.
392.10 - 392.72	Gray shale.
392.72 - 394.50	Dark shale.

Coring was started at a depth of 366.27 feet in fine grained micaceous sandstone and completed at 394.30 feet in dark shale. This core shows a total of 22.23 feet of sandstone. For the most part, the upper part of the sand section is made up of fine grained micaceous slightly shaley sandstone while the lower part is composed of mostly fine grained micaceous carbonaceous shaley sandstone. According to the cuttings, there was approximately 14 feet of sand drilled before coring was started.

PERMEABILITY

For the sake of distribution, the core was divided into two sections. The weighted average permeability of the upper and lower sections are 16.74 and 6.16 millidarcys respectively; while that of the pay sand or that part of the sand section extending from the packer setting to the top of the cement plug is 14.17 millidarcys (See Table II). By observing the data given on the coregraph, you will note that the sand section has a fairly irregular permeability profile and is comparatively tight for its depth.

PERCENT SATURATION & OIL CONTENT

The pay sand in this core shows a good weighted average per cent oil saturation, namely, 45.53. The weighted average percent oil saturation of the upper and lower sections are 47.46 and 43.21 respectively. The weighted average percent water saturation of the upper and lower sections are 34.31 and 40.69 respectively; the overall average of the pay sand is 34.35 (See Table IV). This gives an overall weighted average total fluid saturation of 82.88 percent.

In an effort to get some idea of the degree of flushing of the sand during coring, all of the saturation samples were analyzed for chloride content. The results of these tests are given in Tables VII and VIII. By observing the data given in these tables and on the coregraph, it is

evident that some flushing of the sand in the upper section did occur during the coring operation as the zones of higher permeability have the lower chloride content. However, we are inclined to believe that most of the oil lost during coring was due to the expansion of gas carried in solution by the oil.

The weighted average oil content of the upper and lower sections are 629 and 623 barrels per acre feet respectively; while that of the pay sand is 649. The total oil content of the pay sand, as shown by this core, is 13,077 barrels per acre (See Table IV).

VISCOSITY

The viscosity of a sample of crude oil taken from the bleeder at a producing well on this lease is 34.8 centipoises at 67° F. The A.P.I. gravity of the oil is 26.3° at 60° F. With other factors being favorable, a sand containing an oil of this viscosity should respond satisfactorily to water repressuring.

LABORATORY FLOODING TESTS

The sand in this core did not respond very well to laboratory flooding tests as a total recovery of only 1,464 barrels of oil per acre was obtained from 11.72 feet of sand. The weighted average percent oil saturation was reduced from 46.47 to 37.48, or represents an average recovery of 8.99 percent. The weighted average effective permeability of the samples is 0.35 millidarcys while the average initial fluid production pressure is 25 pounds per square inch (See Table VI).

Of the 24 samples tested, 15 produced oil and took water. Furthermore, all of these samples were in the upper section. The results of these tests indicate that the more or less carbonaceous sand located below the limestone break or in the lower section is not floodable. It is also noticeable that the sand samples after flooding have a compara-

tively high residual oil saturation and a low effective permeability for its depth.

Conclusion

From a study of the above data, we believe that an efficient water flood within the vicinity of this well will recover approximately 1,800 barrels of oil per acre from that part of the sand section analyzed. In calculating this recovery, an allowance was made for oil lost during coring and it was assumed that the true water saturation of the sand is 30 percent.

The principle drawback of the sand in this core is the fact that the viscosity of the oil is fairly high for the permeability of the sand. This probably accounts for the fact that the sand after flooding has a comparatively high residual oil saturation. Furthermore, it is evident that the so-called carbonaceous sand located in the lower part of the sand section is not floodable.

Oil Field Research Laboratories

SHOT RECOMMENDATION

Company Deep Rock Oil Corporation Lease Engel # 3 Core Test Well No. 1

Depth Interval, Feet	Feet of Sand	Size of Shell Inches.	Qts./Ft.	Total Quarts
369.0 - 381.5	12.5	4½	3.1	38.75

Recommended Packer Setting - 365.0 feet
Note: Plug hole back to - 390.0 feet

Oil Field Research Laboratories

RESULTS OF PERMEABILITY TESTS

TABLE I

Company Deep Rock Oil Corporation Lease Engel # 3 Core Test Well No. 1

Sample No.	Depth, Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
1	366.29	44.	0.13	0.13	5.72
2	366.55	53.	0.35	0.48	18.55
3	366.94	50.	0.55	1.03	27.50
4	367.75	11.	0.65	1.68	7.15
5	368.15	11.	0.25	1.93	2.75
6	368.86	20.	0.52	2.45	10.40
7	369.05	22.	0.40	2.85	8.80
8	369.65	15.	0.40	3.25	6.00
9	369.90	12.	0.45	3.70	5.40
10	370.48	12.	0.55	4.25	6.60
11	371.00	9.7	0.45	4.70	4.36
12	371.35	29.	0.50	5.20	14.50
13	372.00	17.	0.40	5.60	6.80
14	372.25	8.3	0.40	6.00	3.32
15	372.80	5.4	0.40	6.40	2.16
16	373.05	23.	0.60	7.00	13.80
17	373.86	10.	0.45	7.45	4.50
18	374.40	1.7	0.65	8.10	1.10
19	374.67	8.4	0.40	8.50	3.36
20	375.15	14.	0.35	8.85	4.90
21	375.60	16.	0.45	9.30	7.20
22	376.00	6.2	0.45	9.75	2.79
23	376.45	13.	0.35	10.10	4.55
24	376.82	4.6	0.32	10.42	1.47
25	377.34	38.	0.58	11.00	22.04
26	377.76	35.	0.30	11.30	10.50
27	377.98	9.4	0.40	11.70	3.76
28	378.50	20.	0.40	12.10	8.00
29	378.95	16.	0.30	12.40	4.80
30	379.50	9.6	0.55	12.95	5.28
31	379.97	7.0	0.40	13.35	2.80
32	380.23	39.	0.30	13.65	11.70
33	380.60	20.	0.30	13.95	6.00
34	380.85	18.	0.20	14.15	3.60
35	381.45	1.0	0.40	14.55	0.40
36	382.15	5.1	0.77	15.32	3.93
37	384.20	Imp.	0.40	15.72	0.00
38	384.65	8.3	0.50	16.22	4.15
39	384.90	11.	0.30	16.52	3.30
40	385.30	26.	0.35	16.87	9.10

Oil Field Research Laboratories

RESULTS OF PERMEABILITY TESTS

TABLE I

Company Deep Rock Oil Corporation Lease Engel # 3 Core Test Well No. 1

Sample No.	Depth, Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
41	385.60	8.0	0.35	17.22	2.80
42	386.00	7.9	0.35	17.57	2.76
43	386.30	4.7	0.35	17.92	1.64
44	386.66	3.1	0.85	18.77	2.63
45	387.40	1.2	0.40	19.17	0.48
46	388.10	15.	0.65	19.82	9.75
47	388.90	3.2	0.65	20.47	2.08
48	389.10	4.2	0.55	21.02	2.31
49	389.90	0.93	0.60	21.62	0.56
50	390.50	Imp.	0.40	22.02	0.00
51	391.05	0.40	0.50	22.52	0.20
52	391.20	0.99	0.45	22.97	0.45
53	391.80	Imp.	0.55	23.52	0.00

Oil Field Research Laboratories

SUMMARY OF PERMEABILITY TESTS

TABLE II

Company Deep Rock Oil Corporation Lease Engel # 3 Core Test Well No. 1

Depth Interval Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity, Ft. x Md.
366.27 - 382.27	15.32	16.74	256.49
384.30 - 392.10	6.85	6.16	42.23
366.27 - 390.00	21.02	14.17	297.86

Oil Field Research Laboratories

RESULTS OF SATURATION TESTS

TABLE III

Company Deep Rock Oil Corporation Lease Engel # 3 Core Test Well No. 1

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.	
1	366.32	19.4	39.2	37.1	76.3	591	0.73	0.73	431
2	367.53	17.8	44.9	37.6	82.5	620	1.20	1.93	745
F-3	368.65	17.6	44.2	-	-	613	0.57	2.50	349
4	369.20	15.2	50.2	42.0	92.2	593	0.75	3.25	445
F-5	370.10	16.3	44.6	-	-	565	0.65	3.90	367
5	370.75	17.5	48.3	32.8	81.1	657	0.70	4.60	460
6	371.82	16.8	47.2	33.0	80.2	616	1.00	5.60	616
7	372.65	15.7	39.2	38.8	78.0	478	1.00	6.60	478
8	373.65	18.5	33.0	27.9	60.9	763	0.85	7.45	649
F-9	374.10	15.8	49.2	-	-	603	0.35	7.80	211
9	374.65	15.9	53.4	34.8	88.2	660	0.70	8.50	462
F-10	375.35	16.9	50.8	-	-	746	0.60	9.10	449
10	375.80	15.7	49.3	36.5	85.8	602	0.60	9.70	362
11	376.66	16.6	45.3	32.3	77.6	585	0.70	10.40	410
12	377.55	19.8	45.7	26.1	71.8	704	0.88	11.28	620
F-13	378.25	16.7	45.7	-	-	592	0.60	11.88	356
13	378.78	14.8	62.8	33.0	95.8	782	0.50	12.38	382
14	379.28	15.5	49.5	33.7	83.2	596	0.35	12.73	208
F-14	379.78	17.0	51.4	-	-	679	0.60	13.33	407

Oil Field Research Laboratories

RESULTS OF SATURATION TESTS

TABLE III

Company Deep Rock Oil Corporation Lease Engel # 3 Core Test Well No. 1

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.	
F-15	380.45	18.7	46.0	-	-	668	0.80	14.13	535
15	380.99	18.0	46.0	28.3	74.3	645	0.20	14.33	129
16	381.98	15.3	48.9	35.1	84.0	561	0.77	15.10	448
18	384.80	17.2	46.8	30.4	77.2	626	0.90	16.00	565
19	385.80	21.3	62.2	26.2	88.4	1,030	0.95	16.95	980
20	386.51	17.5	64.1	24.0	88.1	871	0.60	17.55	524
F-20	387.02	17.6	62.7	-	-	856	0.60	18.15	515
21	387.60	16.3	46.0	46.1	92.1	584	0.55	18.70	321
22	388.30	15.6	43.8	42.0	85.8	532	0.50	19.20	266
23	389.21	13.9	28.1	51.1	79.2	304	0.45	19.65	137
F-24	390.10	14.3	48.5	-	-	540	0.70	20.35	378
24	390.36	11.9	29.3	70.3	99.6	273	0.40	20.75	109
25	390.70	14.0	39.5	53.5	93.0	430	0.40	21.15	172
26	391.30	15.2	25.7	53.6	79.3	304	0.55	21.70	167
F-26	392.01	12.9	56.1	-	-	564	0.55	22.25	321
								Total -	- 13,934

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SUMMARY OF SATURATION TESTS

TABLE IV

Company Deep Rock Oil Corporation Lease Engel # 3 Core Test Well No. 1

Depth Interval, Feet	Feet of Core Analyzed	Average Percent Porosity	Average Percent Oil Saturation	Average Percent Water Saturation	Average Oil Content Bbls./A. Ft.	Total Oil Content Bbls./Acre
366.27-382.27	15.10	17.01	47.46	34.31	629	9,499
384.30-392.10	7.15	16.80	48.21	40.59	623	4,455
366.27-390.00	20.15	17.07	48.53	34.33	649	13,077

Oil Field Research Laboratories

RESULTS OF LABORATORY FLOODING TESTS

TABLE V

Company Deep Rock Oil Corporation Lease Engel No. 3 Core Test Well No. 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.
			Percent	Bbls./A. Ft.	Percent	Bbls./A. Ft.	% Oil	% Water	Bbls./A. Ft.			
1	366.80	20.8	37.1	582	3.9	61	33.2	64.6	521	101	3.14	15
2	367.25	19.3	43.7	656	8.7	131	35.0	64.6	525	104	2.68	15
3	368.65	17.8	44.2	613	10.1	140	34.1	64.7	473	13.5	0.334	20
4	369.40	17.9	41.3	574	9.0	125	32.3	64.3	449	15	0.389	20
5	370.10	16.3	44.6	565	7.0	89	37.6	60.6	476	3	0.099	35
6	371.50	18.1	46.3	658	13.1	185	33.2	64.3	467	18.5	0.420	20
7	372.40	16.7	41.9	545	5.9	77	36.0	59.5	468	5	0.146	35
8	373.25	17.8	57.5	797	16.4	227	41.1	58.5	570	31	0.736	15
9	374.10	15.8	49.2	602	0.0	0	49.2	49.5	603	1	0.095	50
10	375.35	16.9	50.8	748	8.0	118	42.8	53.4	630	7	0.342	25
11	376.25	17.1	51.5	687	7.8	104	43.7	54.8	585	9	0.191	30
12	377.05	18.3	47.7	678	13.6	193	34.1	62.5	485	42	1.14	15
13	378.25	16.7	45.7	592	0.8	10	44.9	49.7	582	4	0.194	40
14	379.78	17.0	51.4	679	5.1	67	46.3	50.2	612	1.5	0.094	45
15	380.45	18.7	46.0	668	6.1	89	39.9	57.7	579	21	0.513	25
16	381.60	18.5	49.9	718	14.6	210	35.3	49.5	508	27	0.685	20
18	384.43	16.4	44.4	566	0.0	0	44.4	57.7	566	0	Imp.	50 +
19	385.45	16.8	64.5	842	0.0	0	64.5	23.3	842	0	Imp.	50 +
20	387.02	17.6	62.7	856	0.0	0	62.7	26.0	856	0	Imp.	50 +
21	387.90	19.1	44.5	660	0.0	0	44.5	25.8	660	0	Imp.	50 +
23	389.69	13.6	28.7	304	0.0	0	28.7	53.5	304	0	Imp.	50 +
24	390.10	14.3	48.5	540	0.0	0	48.5	31.0	540	0	Imp.	50 +
25	390.89	14.8	40.1	460	0.0	0	40.1	46.7	460	0	Imp.	50 +
26	392.01	12.9	58.1	584	0.0	0	58.1	37.6	584	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.

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SUMMARY OF LABORATORY FLOODING TESTS

TABLE VI

Company Deep Rock Oil Corporation Lease Engel # 3 Core Test Well No. 1

Depth Interval, Feet	366.27 - 382.27
Feet of Core Analyzed	11.72
Average Percent Porosity	15.03
Average Percent Original Oil Saturation	46.47
Average Percent Oil Recovery	8.99
Average Percent Residual Oil Saturation	37.48
Average Percent Residual Water Saturation	59.16
Average Percent Total Residual Fluid Saturation	96.64
Average Original Oil Content, Bbls./A. Ft.	651.
Average Oil Recovery, Bbls./A. Ft.	127.
Average Residual Oil Content, Bbls./A. Ft.	524.
Total Original Oil Content, Bbls./Acre	7,624.
Total Oil Recovery, Bbls./Acre	1,484.
Total Residual Oil Content, Bbls./Acre	6,140.
Average Effective Permeability, Millidarcys	0.85
Average Initial Fluid Production Pressure, p.s.i.	85.0

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

Oil Field Research Laboratories

RESULTS OF WATER DIFFERENTIATION TESTS

TABLE VII

Company Deep Rock Oil Corporation Lease Engel # 3 Core Test Well No. 1

Sample No.	Depth, Feet	Chloride Content of Brine in Sand ppm	Percent Water Saturation		
			Connate	Drilling & Foreign	Total
1	366.32	11,700			
2	367.55	15,000			
4	369.20	12,780			
5	370.75	15,000			
6	371.82	12,780			
7	372.65	14,430			
8	373.65	14,950			
9	374.65	14,530			
10	375.80	15,400			
11	376.66	14,700			
12	377.55	11,830			
13	378.78	13,350			
14	379.28	15,400			
15	380.99	13,750			
16	381.98	13,530			
18	384.80	12,000			
19	385.80	12,400			
20	386.51	13,030			
21	387.60	11,700			
22	388.30	13,400			
23	389.21	12,830			
24	390.36	9,800			
25	390.70	10,950			
26	391.30	10,900			

Note: ppm - parts per million

Oil Field Research Laboratories

SUMMARY OF WATER DIFFERENTIATION TESTS

TABLE VIII

Company Deep Rock Oil Corporation Lease Engel # 3 Core Test Well No. 1

Depth Interval, Feet	Chloride Content of Brine in Sand, ppm	Average Percent Connate Water	Average Percent Drilling & Foreign Water
366.27 - 382.27	13,902		
384.30 - 391.38	11,968		
366.27 - 390.00	13,589		

Note: ppm - parts per million