December 15, 1950

Deep Rock Oil Corporation
Atlas Life Building
Tulsa, Oklahoma

Attention: Mr. T. F. Lawry

Gentlemen:

Enclosed herewith is the report of the analysis made on the 2½" rotary core taken from the Engel Lease, Well No. G-9, Crawford County, Kansas, and submitted to our laboratory on November 24, 1950.

Very truly yours,

OIL FIELD RESEARCH LABORATORIES

Carl L. Pete

CLP:mm

c.c. to Mr. Neil Henderson
Mr. Jack West

DEEP ROCK OIL CORPORATION

CORE ANALYSIS REPORT

ENGEL LEASE WELL NO. C-9

CRAWFORD COUNTY, KANSAS

OIL FIELD RESEARCH LABORATORIES

CHANUTE, KANSAS

DECEMBER 15, 1950

Oil Field Research Laboratories

GENERAL INFORMATION & SUMMARY

Company Deep Rock Oil Corporation Lease Engel Well No. 6-9

Location NE¼

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

Name of Sand	Bartlesville
Top of Core	369.45
Bottom of Core	397.80
Top of Pay Sand	374.80
Bottom of Pay Sand	387.20
Total Feet of Permeable Sand	11.00

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 10	0.95	0.95
10 - 20	3.12	4.07
20 - 30	3.20	7.27
30 & above	3.73	11.00

Average Permeability, Millidarcys	26.72
Average Percent Porosity	17.69
Average Percent Oil Saturation	44.96
Average Percent Water Saturation	31.12
Average Oil Content, Bbls./A. Ft.	620.
Total Oil Content, Bbls./Acre	6,109.
Average Percent Oil Recovery by Laboratory Flooding Tests	10.07
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	141.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	1,392.
Total Calculated Oil Recovery, Bbls./Acre	2,550.
Packer Setting, Feet	375.00
Viscosity, Centipoises @ 68° F.	64.5
A. P. I. Gravity, degrees @ 60 °F	25.2

The above averages are for that part of the cored section extending from the packer setting 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
369.45 - 369.80	Light brown fine grained micaceous slightly shaley sandstone.
369.80 - 371.60	Light brown fine grained micaceous sandstone.
371.60 - 372.35	Light brown fine grained slightly laminated micaceous shaley sandstone.
372.35 - 374.15	Light brown fine grained micaceous sandstone.
374.15 - 374.80	Light brown fine grained slightly laminated micaceous shaley sandstone.
374.80 - 375.15	Brown fine grained micaceous sandstone.
375.15 - 375.30	Brown fine grained laminated micaceous shaley sandstone.
375.30 - 376.15	Light brown fine grained micaceous sandstone.
376.15 - 380.15	Brown fine grained micaceous sandstone containing two shale breaks.
380.15 - 380.42	Gray sandy shale containing a sandstone streak.
380.42 - 380.62	Brown fine grained micaceous sandstone.
380.62 - 380.72	Gray sandy shale.
380.72 - 381.50	Brown fine grained micaceous sandstone.
381.50 - 381.77	Gray sandy shale.
381.77 - 382.60	Brown fine grained micaceous sandstone.
382.60 - 382.80	Sandstone and shale containing a sandy lamination.
382.80 - 387.20	Brown fine grained micaceous sandstone.
387.20 - 388.20	Brown fine grained micaceous carbonaceous sandstone.

388.20 - 394.95 - Dark fine grained micaceous carbonaceous sandstone.

394.95 - 395.60 - Gray shale.

395.60 - 395.91 - Dark fine grained micaceous carbonaceous sandstone.

395.91 - 396.70 - Gray shale.

396.70 - 397.80 - According to log, gray shale (discarded at well).

Coring was started at a depth of 369.45 feet in fine grained micaceous slightly shaley sandstone and completed at 397.80 feet in gray shale. This core shows a total of 23.70 feet of sand. For the most part, the pay sand is made up of fine grained micaceous 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 are 11.76, 26.83 and 6.46 millidarcys respectively while that of the pay sand, or that part of the cored section extending from the packer setting to the top of the cement plug, is 26.72 (See Table II). From the above data and that given on the coregraph, it is noticeable that the sand has a fairly irregular permeability profile and is comparatively tight.

PERCENT SATURATION & OIL CONTENT

The pay sand in this core shows a good weighted average percent oil saturation, namely, 44.96. The weighted average percent oil saturation of the upper, middle and lower sections are 32.86, 45.12 and 50.32 respectively. The weighted average percent water saturation of the upper, middle and lower sections are 46.66, 31.05 and 36.18 respectively while that of the pay sand is 31.12 (See Table IV). This gives an overall weighted average total fluid saturation of 76.08 percent. This comparatively low total fluid saturation indicates that an appreciable

amount of 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 VII and VIII. From the data given in these tables and on the coregraph, it is evident that some flushing of the sand did occur during coring; however, we are of the opinion 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, middle and lower sections are 410, 623 and 666 barrels per acre foot respectively while that of the pay sand is 620. The total oil content, as shown by this core, is 13,211 barrels per acre of which 6,109 barrels are in the pay sand section (See Table IV).

VISCOSITY

The viscosity of a sample of crude oil taken from Well No. C-13 is 64.5 centipoises at 68° F. The A.P.I. gravity of the oil is 25.2° at 60° F. The viscosity of this oil is considerably higher than the average found in the good floodable sands in this area.

LABORATORY FLOODING TESTS

The pay sand in this core responded fairly well to laboratory flooding tests as a total recovery of 1,392 barrels of oil per acre was obtained from 9.87 feet of sand. The weighted average percent oil saturation was reduced from 44.28 to 34.21, or represents an average recovery of 10.07 percent. The weighted average effective permeability of the samples is 0.856 millidarcys while the average initial fluid production pressure is 28.6 pounds per square inch (See Table VI). The above tests

show that the sand after flooding had a fairly high residual oil saturation.

From the data given in Table V, you will note that of the 19 samples tested, 13 produced water and 11 oil. These tests show that somewhat less than half of the sand represented by these samples is floodable. The tests also show that the sand has a low effective permeability.

CONCLUSION

From a study of the above data, we believe that an efficient water flood within the vicinity of this well will recover approximately 2,550 barrels of oil per acre, or an average of 298 barrels per acre foot provided the sand will take water satisfactorily. In calculating this recovery, an allowance was made for oil lost during coring and it is assumed that the well was drilled in virgin territory.

The principle drawback of the sand in this core is the fact that it is comparatively tight for its depth and contains a rather viscous oil. Chances are the input rate could be increased somewhat and a higher ultimate oil recovery could be obtained if approximately 100 barrels of fuel oil, a distillate, or plain white gasoline were injected into each of the input wells prior to water injection.

Oil Field Research Laboratories

SHOT RECOMMENDATION

Company Deep Rock Oil Corporation Lease Engel Well No. 9-9

Depth Interval, Feet	Feet of Sand	Size of Shell Inches	Qts./Ft.	Total Quarts
379.0 - 386.0	7.0	4½	3.1	21.7

Recommended Packer Setting 375.0 feet
Note: Plug hole back to 387.0 feet

Oil Field Research Laboratories

RESULTS OF PERMEABILITY TESTS

TABLE I

Company Deep Rock Oil Corporation Lease Engel Well No. G-9

Sample No.	Depth, Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
1	369.65	12.	0.35	0.35	4.20
2	370.04	14.	0.50	0.85	7.00
3	370.52	9.3	0.50	1.35	4.65
4	371.06	32.	0.45	1.80	14.40
5	371.51	30.	0.35	2.15	10.50
6	372.00	8.7	0.75	2.90	6.53
7	372.40	4.4	0.35	3.25	1.54
8	373.00	2.0	0.50	3.75	1.00
9	373.40	11.	0.55	4.30	6.05
10	374.04	Cracked	0.40	4.70	-
11	374.40	3.8	0.65	5.35	2.47
12	375.22	3.4	0.15	5.50	0.51
13	375.60	9.9	0.50	6.00	4.95
14	376.06	13.	0.35	6.35	4.55
15	376.94	27.	0.90	7.25	24.30
16	377.25	15.	0.21	7.46	3.15
17	377.92	14.	0.73	8.19	10.22
18	378.25	22.	0.30	8.49	6.60
19	378.53	13.	0.40	8.89	5.20
20	379.06	7.2	0.30	9.19	2.16
21	379.18	28.	0.50	9.69	14.00
22	379.87	24.	0.55	10.24	13.20
23	380.55	10.	0.20	10.44	2.00
24	380.95	43.	0.78	11.22	33.54
25	381.90	15.	0.23	11.45	3.45
26	382.10	50.	0.60	12.05	30.00
27	382.84	10.	0.45	12.50	4.50
28	383.58	20.	0.45	12.95	9.00
29	383.91	23.	0.50	13.45	11.50
30	384.55	30.	0.55	14.00	16.50
31	384.97	30.	0.30	14.30	9.00
32	385.15	15.	0.55	14.85	8.25
33	385.88	63.	0.40	15.25	25.20
34	386.20	51.	0.30	15.55	15.30
35	386.35	52.	0.55	16.10	28.60
36	387.10	33.	0.45	16.55	14.85
37	387.63	12.	0.60	17.15	7.20
38	387.97	3.5	0.25	17.40	0.88
39	388.15	13.	0.15	17.55	1.95
40	388.75	7.4	0.80	18.35	5.92

Oil Field Research Laboratories

RESULTS OF PERMEABILITY TESTS

TABLE I

Company Deep Rock Oil Corporation Lease Engel Well No. G-9

Sample No.	Depth, Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
41	389.42	6.9	0.75	19.10	5.18
42	390.15	14.	0.60	19.70	8.40
43	390.60	11.	0.70	20.40	7.70
44	391.53	6.7	0.65	21.05	4.36
45	391.86	5.2	0.30	21.35	1.56
46	392.13	2.8	0.50	21.85	1.40
47	392.84	3.1	0.60	22.45	1.86
48	393.32	1.5	0.40	22.85	0.60
49	393.74	1.3	0.40	23.25	0.52
50	394.07	2.4	0.35	23.60	0.84
51	394.47	2.5	0.45	24.05	1.13
52	394.88	2.3	0.25	24.30	0.58
53	395.75	Imp.	0.31	24.61	0.00

Oil Field Research Laboratories

SUMMARY OF PERMEABILITY TESTS

TABLE II

Company Deep Rock Oil Corporation Lease Engel Well No. 9-9

Depth Interval Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity, Ft. x Md.
369.45 - 375.15	4.95	11.76	58.34
375.15 - 387.20	11.20	26.83	300.53
387.20 - 395.91	7.75	6.46	50.08
375.00 - 387.00	11.00	26.72	293.93

Oil Field Research Laboratories

RESULTS OF SATURATION TESTS

TABLE III

Company Deep Rock Oil Corporation Lease Engel Well No. G-9

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	371.25	17.0	27.8	39.7	67.5	367	1.80	1.80	661
2	373.60	16.0	34.7	39.4	74.1	432	1.80	3.60	778
3	374.64	15.2	34.7	53.7	88.4	409	0.65	4.25	266
F-3	374.98	17.3	38.4	-	-	521	0.35	4.60	182
4	376.35	16.5	40.2	30.0	70.2	514	0.65	5.25	334
5	377.48	16.5	48.3	32.1	80.4	619	1.19	6.44	737
6	378.72	16.7	45.6	30.0	75.6	591	1.00	7.44	591
7	379.40	18.7	45.3	30.3	75.8	658	1.05	8.49	691
8	381.37	19.1	45.3	27.3	72.6	672	0.78	9.27	524
9	382.30	19.4	46.6	24.2	70.8	702	0.83	10.10	583
10	383.34	16.4	44.5	41.4	85.9	568	0.90	11.00	511
11	384.14	15.9	42.2	39.6	81.8	521	1.05	12.05	547
12	385.65	18.5	47.5	27.4	74.9	682	1.35	13.40	921
13	386.55	19.6	43.3	27.8	71.1	658	1.10	14.50	724
14	387.33	17.3	60.6	30.2	90.8	814	1.00	15.50	814
15	388.30	17.2	58.3	23.7	82.0	779	0.90	16.40	701
16	389.92	17.4	50.6	27.8	78.4	683	1.25	17.65	854
17	390.90	17.9	63.1	25.6	88.7	877	1.25	18.90	1,096
18	392.39	16.5	42.8	42.8	85.6	550	1.50	20.40	825
19	393.92	15.9	38.2	52.9	91.1	471	1.85	22.25	871
							Total	- - - -	13,211

Oil Field Research Laboratories

SUMMARY OF SATURATION TESTS

TABLE IV

Company Deep Rock Oil Corporation Lease Engel Well No. 8-9

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
369.80-375.15	4.60	16.36	32.26	46.66	410	1,887
376.20-387.20	9.90	17.64	45.12	31.05	623	6,163
387.20-394.95	7.75	16.93	50.32	36.18	666	5,161
375.00-387.00	9.85	17.69	44.96	31.12	620	6,109

Oil Field Research Laboratories

RESULTS OF LABORATORY FLOODING TESTS

TABLE V

Company Deep Rock Oil Corporation Lease Engel Well No. G-9

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	370.80	16.3	27.0	342	0.0	0	27.0	63.9	342	54	1.76	25
2	373.85	16.0	32.7	407	0.0	0	32.7	57.6	407	11	0.280	40
3	374.97	17.5	38.4	521	6.8	92	31.6	55.5	429	6	0.185	30
4	376.65	16.5	39.8	510	5.4	69	34.4	57.8	441	9.5	0.261	30
5	377.72	16.3	47.4	599	7.6	96	39.8	45.8	503	4	0.160	35
6	378.91	16.4	45.1	574	6.3	80	38.8	48.4	494	2	0.092	40
7	379.68	19.2	44.1	658	10.3	154	33.8	61.7	504	34	1.03	20
8	381.10	18.7	46.7	677	16.7	242	30.0	59.9	435	30	0.941	20
9	382.50	19.5	45.3	686	13.7	208	31.6	61.6	478	51	1.43	20
10	383.05	17.3	43.9	589	9.3	125	34.6	54.2	464	9	0.278	30
11	384.40	16.6	40.2	518	8.6	111	31.6	59.2	407	12	0.260	30
12	385.34	18.2	46.2	653	14.3	202	31.9	56.5	451	30	0.847	25
13	386.82	19.2	43.0	641	8.3	124	34.7	58.2	517	11	0.384	35
14	387.80	17.5	58.8	800	0.0	0	58.8	32.3	800	0	Imp.	50+
15	388.55	17.2	58.6	783	0.0	0	58.6	23.9	783	0	Imp.	50+
16	389.62	17.5	51.8	705	0.0	0	51.8	30.0	705	0	Imp.	50+
17	391.26	17.1	64.2	853	0.0	0	64.2	30.0	853	0	Imp.	50+
18	392.63	16.2	43.1	542	0.0	0	43.1	45.7	542	0	Imp.	50+
19	394.28	14.9	39.9	462	0.0	0	39.9	46.4	462	0	Imp.	50+

Note: 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 Well No. 6-9

Depth Interval, Feet	375.00 - 387.00
Feet of Core Analyzed	9.87
Average Percent Porosity	17.77
Average Percent Original Oil Saturation	44.28
Average Percent Oil Recovery	10.07
Average Percent Residual Oil Saturation	34.21
Average Percent Residual Water Saturation	55.91
Average Percent Total Residual Fluid Saturation	90.12
Average Original Oil Content, Bbls./A. Ft.	611.
Average Oil Recovery, Bbls./A. Ft.	141.
Average Residual Oil Content, Bbls./A. Ft.	470.
Total Original Oil Content, Bbls./Acre	6,028.
Total Oil Recovery, Bbls./Acre	1,392.
Total Residual Oil Content, Bbls./Acre	4,636.
Average Effective Permeability, Millidarcys	0.556
Average Initial Fluid Production Pressure, p.s.i.	28.6

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

Oil Field Research Laboratories

RESULTS OF WATER DIFFERENTATION TESTS

TABLE VII

Company Deep Rock Oil Corporation Lease Engel Well No. C-9

Sample No.	Depth, Feet	Chloride Content of Brine in Sand ppm	Percent Water Saturation Connate	Drilling & Foreign	Total
1	371.25	9,400			
2	373.60	10,900			
3	374.64	28,700			
4	376.35	13,100			
5	377.48	12,000			
6	378.72	14,700			
7	379.40	15,400			
8	381.37	16,200			
9	382.30	13,900			
10	383.34	12,900			
11	384.14	11,400			
12	385.65	12,900			
13	386.55	14,000			
13	387.33	16,800			
15	388.30	16,300			
16	389.92	16,000			
17	390.90	18,900			
18	392.39	13,700			
19	393.92	18,400			

Note: ppm - parts per million

Oil Field Research Laboratories

SUMMARY OF WATER DIFFERENTATION TESTS

TABLE VIII

Company Deep Rock Oil Corporation Lease Engel Well No. G-9

Depth Interval, Feet	Chloride Content of Brine in Sand, ppm	Average Percent Connate Water	Average Percent Drilling & Foreign Water
369.80 - 374.80	12,987		
376.20 - 387.20	13,557		
387.20 - 394.95	16,734		
375.00 - 387.00	13,550		

Notes: ppm - parts per million