November 25, 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-13, Crawford County, Kansas, and submitted to our laboratory on October 30, 1950.

Very truly yours,

OIL FIELD RESEARCH LABORATORIES

Carl L. Pate

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

DEEP ROCK OIL CORPORATION

CORE ANALYSIS REPORT

ENGEL LEASE WELL NO. G-13

CRAWFORD COUNTY, KANSAS

OIL FIELD RESEARCH LABORATORIES

CHANUTE, KANSAS

NOVEMBER 25, 1950

Oil Field Research Laboratories

GENERAL INFORMATION & SUMMARY

Company Deep Rock Oil Corporation Lease Engel Well No. C-13

Location NE¼

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

Name of Sand	Bartlesville
Top of Core	352.91
Bottom of Core	395.29
Top of Pay Sand	375.60
Bottom of Pay Sand	386.20
Total Feet of Permeable Sand	8.54

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 15	0.81	0.81
15 - 30	2.30	3.10
30 - 45	2.63	5.74
45 & above	2.80	8.54

Average Permeability, Millidarcys	41.74
Average Percent Porosity	18.89
Average Percent Oil Saturation	47.13
Average Percent Water Saturation	31.07
Average Oil Content, Bbls./A. Ft.	692.
Total Oil Content, Bbls./Acre	6,802.
Average Percent Oil Recovery by Laboratory Flooding Tests	10.33
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	153.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	1,145.
Total Calculated Oil Recovery, Bbls./Acre	1,950.
Packer Setting, Feet	376.50
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	

Note: The above averages are for that part of the sand 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
352.91 - 356.90	Laminated sandy shale.
356.90 - 359.40	Laminated shaley sandstone.
359.40 - 360.35	Laminated sandy shale.
360.35 - 360.75	Laminated shaley sandstone.
360.75 - 361.50	Laminated sandy shale.
361.50 - 362.25	Gray shale.
362.25 - 364.00	Laminated sandy shale.
364.00 - 364.24	Light brown fine grained micaceous shaley sandstone.
364.24 - 364.40	Gray sandy shale.
364.40 - 364.57	Light brown fine grained micaceous shaley sandstone.
364.57 - 365.20	Gray sandy shale.
365.20 - 365.40	Light brown fine grained micaceous sandstone.
365.40 - 365.70	Laminated sandy shale.
365.70 - 365.90	Light brown fine grained micaceous shaley sandstone.
365.90 - 366.05	Light brown fine grained laminated micaceous shaley sandstone.
366.05 - 366.30	Light brown fine grained micaceous shaley sandstone.
366.30 - 366.77	Laminated sandy shale.
366.77 - 374.50	Light brown fine grained micaceous slightly shaley sandstone.
374.50 - 374.75	Brown fine grained micaceous sandstone.
374.75 - 375.08	Light brown fine grained micaceous sandstone.
375.08 - 375.60	Light brown fine grained slightly laminated micaceous shaley sandstone.

375.60 - 376.60 - Brown fine grained micaceous sandstone.

376.60 - 376.75 - Brown fine grained micaceous shaley sandstone.

376.75 - 377.98 - Brown fine grained micaceous sandstone.

377.98 - 378.08 - Gray shale.

378.08 - 378.60 - Brown fine grained micaceous sandstone.

378.60 - 379.25 - Laminated sandy shale.

379.25 - 379.41 - Brown fine grained micaceous slightly shaley sandstone.

379.41 - 379.57 - Laminated sandy shale.

379.57 - 380.60 - Dark brown fine grained micaceous sandstone.

380.60 - 380.70 - Laminated sandstone and shale.

380.70 - 380.90 - Brown fine grained micaceous sandstone.

380.90 - 381.40 - Brown fine grained micaceous shaley sandstone.

381.40 - 385.95 - Brown fine grained micaceous sandstone.

385.95 - 386.20 - Brown fine grained micaceous shaley sandstone.

386.20 - 387.00 - Brown fine grained micaceous sandstone.

387.00 - 387.90 - Dark fine grained micaceous carbonaceous shaley sandstone.

387.90 - 392.40 - Dark fine grained micaceous carbonaceous sandstone.

392.40 - 392.75 - Gray shale.

392.75 - 393.60 - Gray sandy shale.

393.60 - 395.29 - Gray shale.

Coring was started at a depth of 352.91 feet in laminated sandy shale and completed at 395.29 feet in gray shale. This core shows a total of 24.76 feet of sand of which approximately 9.4 feet is oil productive. For the most part, the pay sand is made up of fine grained micaceous to shaley 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 15.27, 40.17 and 7.11 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 41.74 (See Table II). From the data given in the tables and on the coregraph, it is noticeable that the cored section has a very irregular permeability profile.

PERCENT SATURATION & OIL CONTENT

The pay sand in this core shows a good weighted average percent oil saturation, namely, 47.13. The weighted average percent oil saturation of the upper, middle and lower sections are 24.28, 47.47 and 55.96 respectively. The weighted average percent water saturation of the upper, middle and lower sections are 46.30, 30.96 and 31.55 respectively while that of the pay sand is 31.07 (See Table IV). This gives an overall weighted average total fluid saturation of 78.80 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 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. From the data given in these tables and on the coregraph, it is evident that the sand was not flushed very much during coring as the zones of higher permeability do not necessarily have the lower chloride content. This indicates that most of the oil lost during coring was caused by the expansion of gas carried in solution by the oil.

The weighted average oil content of the upper, middle and lower sections are 319, 698 and 695 barrels per acre foot respectively while

that of the pay sand is 692. The total oil content, as shown by this core, is 13,220 barrels per acre of which 6,802 barrels are in the pay sand section (See Table IV).

LABORATORY FLOODING TESTS

The pay sand in this core responded fairly well to laboratory flooding tests as a total recovery of 1,145 barrels of oil per acre was obtained from 7.48 feet of sand. The weighted average percent oil saturation was reduced from 46.39 to 36.06, or represents an average recovery of 10.33 percent. The weighted average effective permeability of the samples is 2.33 millidarcys while the average initial fluid production pressure is 22.0 pounds per square inch (See Table VI). The above tests show that the sand has a rather high residual oil saturation.

By observing the data given in Table V, you will note that of the 21 samples tested, 14 produced water and 11 oil. This indicates that only approximately half of the sand represented by these samples is floodable. The tests also show that the sand has, for the most part, 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 1,930 barrels of oil per acre or an average of 231 barrels per acre foot. In calculating this recovery, an allowance was made for oil lost during coring and it was assumed that the well was drilled in virgin territory.

The principle drawback of the sand in this core is that it is tight for its depth and for the fairly high viscosity of the oil. The sand also has a very irregular effective permeability profile.

Oil Field Research Laboratories

SHOT RECOMMENDATION

Company Deep Rock Oil Corporation Lease Nagel Well No. 6-13

Depth Interval, Feet	Feet of Sand	Size of Shell Inches	Qts./Ft.	Total Quarts
381.50 - 385.50	4.0	4.5	3.1	12.4

Recommended Packer Setting 376.50 feet
Note: Plug hole back to 386.50 feet

Oil Field Research Laboratories

RESULTS OF PERMEABILITY TESTS

TABLE I

Company Deep Rock Oil Corporation Lease Engel Well No. G-13

Sample No.	Depth, Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
1	364.15	0.34	0.24	0.24	0.08
2	364.54	1.5	0.17	0.41	0.26
3	365.37	1.5	0.20	0.61	0.30
4	365.93	0.70	0.15	0.76	0.11
5	366.80	3.5	0.18	0.94	0.63
6	367.04	4.4	0.35	1.29	1.54
7	367.55	11.	0.45	1.74	4.95
8	368.00	15.	0.50	2.24	7.50
9	368.55	2.0	0.33	2.57	0.66
10	368.93	3.0	0.34	2.91	1.02
11	369.28	4.2	0.40	3.31	1.68
12	369.75	9.3	0.50	3.81	4.65
13	370.33	7.6	0.50	4.31	3.80
14	370.64	11.	0.45	4.76	4.95
15	371.23	27.	0.55	5.31	14.85
16	371.73	7.9	0.40	5.71	3.16
17	372.04	5.0	0.40	6.11	2.00
18	372.53	16.	0.50	6.61	8.00
19	373.16	25.	0.55	7.16	13.75
20	373.60	32.	0.45	7.61	14.40
21	373.94	32.	0.70	8.31	22.40
22	374.55	52	0.25	8.56	13.00
23	374.90	22.	0.33	8.89	7.26
24	375.22	8.9	0.27	9.16	2.40
25	375.56	6.5	0.25	9.41	1.63
26	375.86	26.	0.40	9.81	10.40
27	376.24	21.	0.60	10.41	12.60
28	374.70	3.0	0.15	10.56	0.45
29	377.27	15.	0.75	11.31	11.25
30	377.70	35.	0.48	11.79	16.80
31	378.13	26.	0.52	12.31	13.52
32	379.34	11.	0.16	12.47	1.76
33	379.64	26.	0.43	12.90	11.18
34	380.25	92.	0.40	13.30	36.80
35	380.53	40.	0.20	13.50	8.00
36	380.94	7.6	0.15	13.65	1.14
37	381.14	6.4	0.35	14.00	2.24
38	381.47	45.	0.20	14.20	9.00
39	381.74	28.	0.40	14.60	11.20
40	382.25	39.	0.40	15.00	15.60

Oil Field Research Laboratories

RESULTS OF PERMEABILITY TESTS

TABLE I

Company Deep Rock Oil Corporation Lease Engel Well No. C-13

Sample No.	Depth, Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
41	382.50	38.	0.60	15.60	22.80
42	383.43	54.	0.60	16.20	32.40
43	383.84	79.	0.50	16.70	39.50
44	384.30	81.	0.55	17.25	44.55
45	384.95	44.	0.45	17.70	19.80
46	385.23	42.	0.30	18.00	12.60
47	385.60	61.	0.55	18.55	33.55
48	386.26	37.	0.20	18.75	7.40
49	386.50	28.	0.40	19.15	11.20
50	387.15	3.8	0.60	19.75	2.28
51	387.75	6.3	0.50	20.25	3.15
52	388.15	13.	0.60	20.85	7.80
53	388.90	4.3	0.60	21.45	2.58
54	389.27	4.3	0.40	21.85	1.72
55	389.73	5.2	0.50	22.35	2.60
56	390.37	1.0	0.70	23.05	0.70
57	391.00	4.4	0.50	23.55	2.20
58	391.40	0.52	0.55	24.10	0.29
59	392.13	3.3	0.65	24.75	2.15

Oil Field Research Laboratories

SUMMARY OF PERMEABILITY TESTS

TABLE II

Company Deep Rock Oil Corporation Lease Engel Well No. 8-13

Depth Interval Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity, Ft. x Md.
365.70 - 375.60	8.80	15.27	134.34
375.60 - 386.20	9.14	40.17	367.14
386.20 - 392.40	6.20	7.11	44.07
376.50 - 386.50	8.54	41.74	356.44

Oil Field Research Laboratories

RESULTS OF SATURATION TESTS

TABLE III

Company Deep Rock Oil Corporation Lease Engel Well No. C-13

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-1	365.80	15.5	18.3	-	-	221	0.20	0.20	44
1	366.20	17.0	19.6	55.6	75.2	258	0.40	0.60	103
2	367.50	15.9	20.9	60.7	81.6	258	1.03	1.63	266
3	368.20	16.2	23.2	60.0	83.2	292	0.78	2.41	228
4	369.50	16.5	23.8	37.0	60.8	305	1.40	3.81	427
5	370.80	17.2	26.2	39.8	66.0	350	1.55	5.36	543
6	372.96	17.6	21.9	44.1	66.0	299	1.90	7.26	568
7	374.40	17.2	28.2	46.4	74.6	376	1.15	8.41	433
F-8	375.40	17.2	30.2	-	-	403	0.85	9.26	343
8	375.70	17.5	41.4	41.1	82.5	563	1.00	10.26	563
9	376.84	16.8	46.5	35.7	82.2	606	1.38	11.64	836
10	378.30	16.7	44.9	29.7	74.6	583	0.52	12.16	303
11	379.79	20.8	48.8	22.8	71.6	789	1.03	13.19	813
12	380.80	18.5	53.2	26.6	79.8	763	0.20	13.39	153
F-12	381.30	18.0	50.3	-	-	702	0.50	13.89	351
13	381.90	18.9	40.6	29.8	70.4	596	1.00	14.89	596
14	382.84	17.9	42.8	28.1	70.9	595	0.60	15.49	357
15	383.07	18.7	51.1	33.2	84.3	743	0.75	16.24	557
16	384.50	20.8	50.9	29.6	80.5	822	1.35	17.59	1,110
17	385.82	21.4	57.1	26.6	83.7	948	0.85	18.44	806
F-17	386.03	16.2	43.9	-	-	550	0.25	18.69	138
18	386.70	18.2	42.3	34.4	76.7	596	0.80	19.49	477

Oil Field Research Laboratories

RESULTS OF SATURATION TESTS

TABLE III

Company Deep Rock Oil Corporation Lease Engel Well No. G-13

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.	
19	388.36	15.3	62.7	24.6	87.3	744	1.20	20.69	893
20	389.90	14.7	55.0	34.0	89.0	627	1.60	22.29	1,003
21	391.60	16.9	58.7	32.7	91.4	779	1.70	23.99	1,324
							Total	- - - -	13,220

Oil Field Research Laboratories

SUMMARY OF SATURATION TESTS

TABLE IV

Company Deep Rock Oil Corporation Lease Engel Well No. C-13

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
365.70 - 375.80	9.26	16.69	36.28	46.50	319	2,955
375.80 - 386.20	9.43	16.98	47.47	30.96	808	6,365
386.20 - 392.40	5.30	16.02	55.96	31.53	695	3,682
376.50 - 386.50	9.63	16.69	47.13	31.07	802	6,802

Oil Field Research Laboratories

RESULTS OF LABORATORY FLOODING TESTS

TABLE V

Company Deep Rock Oil Corporation Lease Engel Well No. C-13

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	365.80	13.5	18.3	221	0.0	0	18.3	63.0	221	0	Imp.	50#
2	367.22	16.1	20.2	252	0.0	0	20.2	67.5	252	0	Imp.	50#
3	368.40	16.3	21.5	273	0.0	0	21.5	70.7	273	21.5	0.644	25
4	369.60	14.2	36.1	288	0.0	0	36.1	66.9	277	0	Imp.	50#
5	371.05	17.9	24.9	346	1.1	15	23.8	59.4	331	4	0.256	35
6	372.71	17.6	21.4	292	0.0	0	21.4	62.8	292	9	0.297	30
7	374.20	17.0	29.9	394	0.0	0	29.9	67.1	394	11	0.385	30
8	375.40	17.2	30.2	403	0.6	8	29.6	65.7	395	13	0.297	25
9	377.07	18.0	43.2	604	4.3	60	38.9	60.8	544	21.5	0.594	25
10	378.50	16.5	46.6	597	8.2	105	38.4	55.0	492	8	0.205	25
11	380.00	20.1	50.4	776	22.0	339	28.4	67.9	437	39	5.00	10
12	381.30	18.0	50.3	702	9.6	134	40.7	58.5	568	2	0.452	20
13	382.10	19.0	39.9	588	9.5	140	30.4	57.0	448	26	0.999	20
14	382.64	17.8	42.1	581	6.9	95	35.2	62.5	486	1	0.095	35
15	383.30	19.0	52.2	770	14.1	208	38.1	60.2	562	33	1.51	20
16	384.70	20.7	50.2	807	9.2	148	41.0	50.9	659	162	6.40	10
17	386.03	16.2	43.6	550	11.8	148	32.0	59.9	402	4	0.198	30
18	386.90	17.8	43.2	596	0.0	0	43.2	52.4	596	0	Imp.	50#
19	388.63	15.9	62.2	768	0.0	0	62.2	36.6	768	0	Imp.	50#
20	390.13	14.4	58.6	655	0.0	0	58.6	37.2	665	0	Imp.	50#
21	391.84	16.5	57.6	738	0.0	0	57.6	54.7	738	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.

Oil Field Research Laboratories

SUMMARY OF LABORATORY FLOODING TESTS

TABLE VI

Company Deep Rock Oil Corporation Lease Engel Well No. C-13

Depth Interval, Feet	370.15 - 375.60	370.60 - 386.20	376.50 - 386.50
Feet of Core Analyzed	2.55	7.36	7.45
Average Percent Porosity	17.65	16.65	16.64
Average Percent Original Oil Saturation	28.34	46.81	45.39
Average Percent Oil Recovery	0.90	10.46	10.35
Average Percent Residual Oil Saturation	26.04	36.15	36.06
Average Percent Residual Water Saturation	61.64	58.96	59.05
Average Percent Total Residual Fluid Saturation	87.68	95.11	95.11
Average Original Oil Content, Bbls./A. Ft.	388.	683.	679.
Average Oil Recovery, Bbls./A. Ft.	12.	155.	153.
Average Residual Oil Content, Bbls./A. Ft.	336.	528.	526.
Total Original Oil Content, Bbls./Acre	939.	5,037.	5,070.
Total Oil Recovery, Bbls./Acre	51.	1,144.	1,145.
Total Residual Oil Content, Bbls./Acre	908.	3,893.	3,925.
Average Effective Permeability, Millidarcys	0.260	2.35	2.35
Average Initial Fluid Production Pressure, p.s.i.	30.0	21.7	22.0

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-13

Sample No.	Depth, Feet	Chloride Content of Brine in Sand ppm	Percent Water Saturation Connate	Drilling & Foreign	Total
1	366.20	15,600			
2	367.50	16,100			
3	368.20	10,700			
4	369.50	13,000			
5	370.80	12,600			
6	372.96	10,000			
7	374.40	11,100			
8	375.70	11,900			
9	376.84	12,800			
10	378.30	18,500			
11	379.79	14,400			
12	380.80	14,300			
13	381.90	14,700			
14	382.84	17,100			
15	383.07	17,700			
16	384.50	11,800			
17	385.82	14,400			
18	386.70	16,200			
19	388.36	23,900			
20	389.90	21,300			
21	391.60	13,700			

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-13

Depth Interval, Feet	Chloride Content of Brine in Sand, ppm	Average Percent Connate Water	Average Percent Drilling & Foreign Water
365.90 - 374.75	12,266		
375.60 - 385.95	14,204		
386.20 - 392.40	18,679		
376.50 - 386.50	14,535		

Note: ppm - parts per million