December 18, 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. I-13, Crawford, County, Kansas, and submitted to our laboratory on November 26, 1950.

Very truly yours,

OIL FIELD RESEARCH LABORATORIES

Carl L. Pate

CLP:cm

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

DEEP ROCK OIL CORPORATION

CORE ANALYSIS REPORT

ENGEL LEASE WELL NO. I-13

CRAWFORD COUNTY, KANSAS

OIL FIELD RESEARCH LABORATORIES

CHANUTE, KANSAS

DECEMBER 18, 1950

Oil Field Research Laboratories

GENERAL INFORMATION & SUMMARY

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

Location NE¼

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

Name of Sand	Bartlesville
Top of Core	373.19
Bottom of Core	393.19
Top of Pay Sand	381.45
Bottom of Pay Sand	389.40
Total Feet of Permeable Sand	9.60

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 10	0.90	0.90
10 - 20	1.80	2.70
20 - 30	1.80	4.50
30 - 40	0.80	5.30
40 - 50	1.45	6.75
50 & above	2.85	9.60

Average Permeability, Millidarcys	34.12
Average Percent Porosity	18.81
Average Percent Oil Saturation	37.32
Average Percent Water Saturation	31.53
Average Oil Content, Bbls./A. Ft.	559.
Total Oil Content, Bbls./Acre	6,074.
Average Percent Oil Recovery by Laboratory Flooding Tests	12.07
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	180.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	1,286.
Total Calculated Oil Recovery, Bbls./Acre	3,458.
Packer Setting, Feet	380.50
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	

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. This core was taken in virgin territory.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
373.19 - 373.70	Light brown fine grained micaceous sandstone.
373.70 - 373.95	Laminated sandstone and shale.
373.95 - 376.30	Light brown fine grained micaceous sandstone.
376.30 - 377.10	Light brown fine grained slightly laminated micaceous shaley sandstone.
377.10 - 379.90	Light brown fine grained micaceous sandstone.
379.90 - 381.05	Brown fine grained micaceous sandstone.
381.05 - 381.30	Brown fine grained slightly laminated micaceous shaley sandstone.
381.30 - 381.45	Gray sandy shale.
381.45 - 384.50	Brown fine grained micaceous sandstone.
384.50 - 384.70	Brown fine grained slightly laminated micaceous shaley sandstone.
384.70 - 389.40	Brown fine grained micaceous sandstone.
389.40 - 389.70	Brown fine grained micaceous carbonaceous sandstone.
389.70 - 391.00	Brown fine grained micaceous slightly shaley sandstone.
391.00 - 391.20	Dark fine grained micaceous carbonaceous sandstone.
391.20 - 391.50	Brown fine grained micaceous shaley sandstone.
391.50 - 391.70	Brown fine grained micaceous sandstone.
391.70 - 392.10	Dark fine grained micaceous carbonaceous sandstone.
392.10 - 393.19	Loss.

Coring was started at a depth of 373.19 feet in fine grained micaceous sandstone and completed at 393.19 feet. There was a loss extending from 392.10 to 393.19 feet. This core shows a total of 18.00 feet of sandstone. 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 two sections. The weighted average permeability of the upper and lower sections are 22.37 and 31.86 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 34.12 (See Table II). By observing the data given on the coregraph, it is noticeable that the sand sections has a fairly uniform permeability profile.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a fairly good weighted average percent oil saturation, namely, 37.38. The weighted average percent oil saturation of the upper and lower sections are 26.84 and 37.77 respectively. The weighted average percent water saturation of the upper and lower sections are 40.38 and 31.21 respectively while that of the pay sand is 31.53 (See Table IV). This gives an overall weighted average total fluid saturation of 68.85 percent. This low total fluid saturation indicates that an appreciable amount of fluid was lost during coring which was probably oil. By observing the data given on the coregraph, it is noticeable that the upper part of the cored section has a considerably lower percent oil saturation and is apparently an intermediate zone between the oil and gas sands. There is a very distinct contact

point between this zone and the oil sand, namely, 379.90 feet.

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 very little flushing of the sand did occur during coring as the sand section has a fairly uniform chloride content profile. This would indicate 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 377 and 368 barrels per acre foot respectively while that of the pay sand is 559. The total oil content, as shown by this core, is 8,480 barrels per acre of which 6,074 barrels are in the pay sand section (See Table IV).

From the data given in Table V, you will note that of the 14 samples tested, 9 produced water and oil. This indicates that only part 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 3,450 barrels of oil per acre, or an average of 416 barrels per acre foot provided the sand will take water satisfactorily. In calculating this recovery, an allowance was made for oil lost during coring.

The principle drawback of the sand in this core is that it is comparatively tight for its depth and the viscosity of the oil in place. The core shows a total of 8.30 feet of good floodable sand.

Oil Field Research Laboratories

SHOT RECOMMENDATION

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

Depth Interval, Feet	Feet of Sand	Size of Shell Inches	Qts./Ft.	Total Quarts
384.5 - 390.5	6.0	4½	3.1	18.6

Recommended Packer Setting 380.5 feet
Note: Plug hole back to 391.5 feet

Oil Field Research Laboratories

RESULTS OF PERMEABILITY TESTS

TABLE I

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

Sample No.	Depth, Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
1	373.38	38.	0.51	0.51	19.38
2	374.10	9.7	0.45	0.96	4.36
3	374.65	14.	0.50	1.46	7.00
4	375.12	23.	0.40	1.86	9.20
5	375.45	26.	0.50	2.36	13.00
6	376.03	14.	0.50	2.86	7.00
7	377.20	2.4	0.30	3.16	0.72
8	377.65	22.	0.40	3.56	8.80
9	378.12	20.	0.50	4.06	10.00
10	378.65	17.	0.60	4.66	10.20
11	379.00	34.	0.30	4.96	10.20
12	379.32	11.	0.70	5.66	7.70
13	379.98	12.	0.30	5.96	3.60
14	380.30	41.	0.40	6.36	16.40
15	380.73	55.	0.45	6.81	24.75
16	381.62	39.	0.30	7.18	11.70
17	381.92	41.	0.45	7.56	18.45
18	382.58	7.5	0.60	8.16	4.50
19	382.90	9.7	0.30	8.46	2.91
20	383.21	54.	0.40	8.86	21.60
21	383.81	44.	0.40	9.26	17.60
22	384.22	28.	0.60	9.86	16.80
23	384.83	22.	0.30	10.16	6.60
24	385.15	23.	0.30	10.46	6.90
25	385.45	15.	0.50	10.96	7.50
26	386.10	57.	0.60	11.56	34.20
27	386.50	55.	0.40	11.96	22.00
28	386.90	54.	0.50	12.46	27.00
29	387.50	58.	0.50	12.96	29.00
30	387.93	20.	0.30	13.26	6.00
31	388.25	45.	0.50	13.76	22.50
32	388.90	30.	0.50	14.26	15.00
33	389.31	28.	0.30	14.56	8.40
34	389.98	14.	0.50	15.06	7.00
35	390.45	15.	0.50	15.56	7.50
36	390.85	19.	0.30	15.86	5.70
37	391.58	15.	0.20	16.06	3.00
38	391.92	14.	0.40	16.46	5.60

Oil Field Research Laboratories

SUMMARY OF PERMEABILITY TESTS

TABLE II

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

Depth Interval Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity, Ft. x Md.
373.19 - 381.30	6.81	22.37	152.31
381.45 - 392.10	9.65	31.86	307.46
380.50 - 391.50	9.60	34.12	327.61

Oil Field Research Laboratories

RESULTS OF SATURATION TESTS

TABLE III

Company Deep Rock Oil Corporation Lease Engel Well No. I-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.	
1	374.30	19.8	26.4	37.1	63.5	406	1.35	1.35	548
2	376.20	17.6	23.3	37.5	60.8	318	1.00	2.35	318
3	376.70	15.1	25.2	48.4	73.6	298	0.50	2.85	149
F-3	376.96	16.5	28.2	-	-	361	0.30	3.15	108
4	378.30	18.3	26.0	40.4	66.4	369	1.80	4.95	664
5	379.52	16.3	24.4	48.2	72.6	308	1.00	5.95	308
6	380.91	19.5	34.8	36.4	71.2	528	1.15	7.10	608
F-6	381.18	15.1	24.2	-	-	284	0.25	7.35	71
7	382.12	19.9	37.6	26.8	64.4	582	1.35	8.70	785
8	383.40	20.7	39.5	29.8	69.3	635	1.10	9.80	698
9	384.40	21.6	37.0	25.6	62.6	621	0.60	10.40	373
F-9	384.60	16.4	26.0	-	-	332	0.20	10.60	66
10	385.65	17.7	40.8	41.7	82.5	562	1.70	12.30	955
11	387.08	20.0	40.7	29.3	70.0	631	1.40	13.70	884
12	388.40	19.1	43.5	28.2	71.7	635	1.60	15.30	1,015
13	389.56	17.3	46.6	31.2	77.8	625	0.30	15.60	187
F-13	389.80	16.9	29.4	-	-	385	1.30	16.90	500
14	391.11	18.5	45.8	33.7	79.5	657	0.20	17.10	132
F-14	391.35	13.6	35.2	-	-	371	0.30	17.40	111
							Total		8,480

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SUMMARY OF SATURATION TESTS

TABLE IV

Company Deep Rock Oil Corporation Lease Engel Well No. I-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
373.95-381.30	7.35	18.00	26.84	40.38	377	2,774
381.45-391.50	10.05	18.87	37.77	31.21	568	5,706
380.50-391.50	10.85	18.81	37.32	31.53	559	6,074

Oil Field Research Laboratories

RESULTS OF LABORATORY FLOODING TESTS

TABLE V

Company Deep Rock Oil Corporation Lease Engel Well No. I-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	374.50	19.5	27.8	420	2.4	36	25.4	66.6	384	101	2.99	20
2	376.45	15.4	27.8	332	0.0	0	27.8	52.5	332	0	Imp.	50+
3	376.96	16.5	28.2	361	0.6	8	27.6	50.4	353	2	0.078	45
4	378.50	18.8	26.1	380	1.1	16	25.0	69.5	364	111	4.16	20
5	379.78	17.9	24.5	340	0.7	10	23.8	64.9	330	30	0.802	25
6	781.18	15.1	24.2	284	0.0	0	24.2	50.0	284	0	Imp.	50+
7	382.38	19.8	38.7	595	8.2	126	30.5	57.3	469	12	0.267	25
8	383.62	20.1	40.2	626	19.0	296	21.2	71.0	330	76	2.24	15
9	384.60	16.4	26.0	332	0.0	0	26.0	60.0	332	0	Imp.	50+
10	385.90	17.6	42.1	575	11.9	163	30.2	57.2	412	13	0.326	25
11	387.31	19.2	41.2	614	15.2	226	26.0	68.9	388	36	0.833	20
12	388.65	19.8	42.4	652	8.0	123	34.4	56.3	529	22	0.525	25
13	389.80	16.9	29.4	385	0.0	0	29.4	59.1	385	0	Imp.	50+
14	391.35	13.6	35.2	371	0.0	0	35.2	57.2	371	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. L-13

Depth Interval, Feet	373.95 - 379.90	381.45 - 389.40
Feet of Core Analyzed	4.45	7.15
Average Percent Porosity	18.65	19.20
Average Percent Original Oil Saturation	26.41	41.04
Average Percent Oil Recovery	1.37	12.07
Average Percent Residual Oil Saturation	25.04	28.97
Average Percent Residual Water Saturation	66.31	61.41
Average Percent Total Residual Fluid Saturation	91.35	90.38
Average Original Oil Content, Bbls./A. Ft.	382.	611.
Average Oil Recovery, Bbls./A. Ft.	20.	180.
Average Residual Oil Content, Bbls./A. Ft.	362.	431.
Total Original Oil Content, Bbls./Acre	1,699.	4,371.
Total Oil Recovery, Bbls./Acre	90.	1,286.
Total Residual Oil Content, Bbls./Acre	1,609.	3,085.
Average Effective Permeability, Millidarcys	2.77	0.752
Average Initial Fluid Production Pressure, p.s.i.	27.5	22.8

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. I-13

Sample No.	Depth, Feet	Chloride Content of Brine in Sand ppm	Percent Water Saturation Connate	Drilling & Foreign	Total
1	374.30	9,800			
2	376.20	11,600			
3	376.70	12,100			
4	378.30	10,100			
5	379.52	10,100			
6	380.91	9,700			
7	382.12	12,100			
8	383.40	13,500			
9	384.40	15,200			
10	385.65	14,700			
11	387.08	11,000			
12	388.40	14,500			
13	389.56	10,400			
14	391.11	13,600			

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. 1-13

Depth Interval, Feet	Chloride Content of Brine in Sand, ppm	Average Percent Connate Water	Average Percent Drilling & Foreign Water
373.95 - 381.05	10,341		
381.45 - 391.20	13,593		
380.50 - 391.20	13,350		

Note: ppm - parts per million