

December 20, 1950

Deep Rock Oil Corporation  
Atlas Life Building  
Tulsa, Oklahoma

Attention: Mr. T. V. Lawry

Gentlemen:

Enclosed herewith is the report of the analysis made on the 2 $\frac{1}{2}$ " rotary core taken from the Engel Lease, Well No. K-11, Crawford County, Kansas, and submitted to our laboratory on November 27, 1950.

Very truly yours,

OIL FIELD RESEARCH LABORATORIES

Carl L. Fate

CLP:mm

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

DEEP ROCK OIL CORPORATION

CORE ANALYSIS REPORT

ENGEL LEASE . WELL NO. K-11

CRAWFORD COUNTY, KANSAS

OIL FIELD RESEARCH LABORATORIES

CHANUTE, KANSAS

DECEMBER 20, 1950

# Oil Field Research Laboratories

## GENERAL INFORMATION & SUMMARY

Company **Deep Rock Oil Corporation** Lease **Engel** Well No. **L-11**  
 Location **NR 1**  
 Section **28** Twp. **28S** Rge. **22E** County **Crawford** State **Kansas**

Name of Sand	<b>Bartlesville</b>
Top of Core	<b>387.38</b>
Bottom of Core	<b>400.29</b>
Top of Sand <b>ray</b> (According to driller)	<b>386.06</b>
Bottom of Sand	<b>398.50</b>
Total Feet of Permeable Sand	<b>11.55</b>

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 5	1.20	1.20
5 - 10	1.07	2.27
10 - 20	2.79	5.06
20 - 30	3.49	8.55
30 - 40	1.10	9.65
40 & above	1.90	11.55

Average Permeability, Millidarcys	<b>23.30</b>
Average Percent Porosity	<b>17.50</b>
Average Percent Oil Saturation	<b>42.97</b>
Average Percent Water Saturation	<b>36.80</b>
Average Oil Content, Bbls./A. Ft.	<b>582.</b>
Total Oil Content, Bbls./Acre	<b>7,161.</b>
Average Percent Oil Recovery by Laboratory Flooding Tests	<b>7.82</b>
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	<b>109.</b>
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	<b>1,171.</b>
Total Calculated Oil Recovery, Bbls./Acre	<b>2,300.</b>
Packer Setting, Feet	<b>386.00</b>
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	

Fresh water was used as a circulating fluid in the coring of the sand in this well. We understand that this well was drilled in virgin territory.

#### FORMATION CORED

The detailed log of the formation cored is as follows:

<u>Depth Interval, Feet</u>	<u>Description</u>
387.38 - 396.95	- Brown fine grained micaceous sandstone containing two shale breaks.
396.95 - 397.16	- Gray sandy shale.
397.16 - 398.50	- Brown fine grained micaceous sandstone.
398.50 - 399.72	- Dark brown fine grained micaceous carbonaceous sandstone.
399.72 - 399.95	- Laminated sandy shale.
399.95 - 400.29	- Dark fine grained micaceous carbonaceous sandstone.

Coring was started at 387.38 feet in fine grained micaceous sandstone and completed at 400.29 feet in dark fine grained micaceous carbonaceous sandstone. According to the driller the top of the oil sand was found at a depth of 386.00 feet. This core shows a total of 12.31 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 29.60 and 12.00 millidarcys respectively; the overall average being 23.30 (See Table II). By observing the data given on the coregraph, it is noticeable that the upper part of the cored section has a fairly uniform permeability profile.

### PERCENT SATURATION & OIL CONTENT

The sand in this well shows a good weighted average percent oil saturation, namely, 48.97. The weighted average percent oil saturation of the upper and lower sections are 41.71 and 44.99 respectively. The weighted average percent water saturation of the upper and lower sections are 37.62 and 35.46 respectively; the overall average being 36.80 (See Table IV). This gives an overall weighted average total fluid saturation of 79.77 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 very little flushing of the sand occurred during coring as the sand has a fairly uniform chloride content. 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 577 and 589 barrels per acre foot respectively; the overall average being 582. The total oil content, as shown by this core, is 7,161 barrels per acre (See Table IV).

### LABORATORY FLOODING TESTS

The sand in this core responded fairly well to laboratory flooding tests as a total recovery of 1,171 barrels of oil per acre was obtained from 10.75 feet of sand. The weighted average percent oil saturation was reduced from 42.51 to 34.69, or represents an average recovery of

7.82 percent. The weighted average effective permeability of the samples is 0.580 millidarcys while the average initial fluid production pressure is 29.6 pounds per square inch (See Table VI). From the data given above, it is noticeable that the sand samples after flooding had a fairly high residual oil saturation.

By observing the data given in Table V, you will note that of the 13 samples tested, 11 produced water and oil. This indicates that most of the sand represented by these samples is floodable. The tests also show that the sand is comparatively tight 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 2,300 barrels of oil per acre, or an average of 21 $\frac{1}{2}$  barrels per acre foot from that part of the sand section analyzed 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 the fact that it is comparatively tight for its depth and the viscosity of the oil in place. The core shows a total of 10.75 feet of floodable sand.

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SHOT RECOMMENDATION

Company Deep Rock Oil Corporation Lease Engel Well No. K-11

Depth Interval, Feet	Feet of Sand	Size of Shell Inches	Qts./Ft.	Total Quarts
390.0 - 397.5	7.5	4½	3.1	23.25

Recommended Packer Setting 386.0 feet

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**RESULTS OF PERMEABILITY TESTS**  
**TABLE I**

Company Deep Rock Oil Corporation Lease Angel Well No. K-11

Sample No.	Depth, Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
1	307.95	11.	0.50	0.50	5.50
2	308.23	7.2	0.25	0.75	1.80
3	308.45	17.	0.35	1.10	5.95
4	309.08	29.	0.56	1.60	14.50
5	309.30	39.	0.30	1.90	11.70
6	309.65	34.	0.50	2.40	17.00
7	390.35	10.	0.50	2.90	5.00
8	390.63	31.	0.30	3.20	9.30
9	390.88	29.	0.40	3.60	11.60
10	391.53	26.	0.40	4.00	10.40
11	391.77	63.	0.40	4.40	17.20
12	392.15	43.	0.40	4.80	17.20
13	392.56	17.	0.40	5.20	6.80
14	392.93	25.	0.50	5.70	14.00
15	393.45	45.	0.50	6.20	22.50
16	393.93	53.	0.60	6.80	31.80
17	394.60	28.	0.62	7.42	17.36
18	395.20	24.	0.42	7.84	10.08
19	396.00	28.	0.35	8.19	9.80
20	396.20	14.	0.15	8.34	2.10
21	396.35	28.	0.30	8.64	8.40
22	396.87	13.	0.35	8.99	4.55
23	397.33	13.	0.54	9.53	7.02
24	397.85	1.4	0.30	9.83	0.42
25	398.12	1.2	0.50	10.33	0.60
26	398.58	9.2	0.40	10.73	3.68
27	399.05	1.4	0.40	11.13	0.56
28	399.65	5.6	0.42	11.55	2.35

**Oil Field Research Laboratories**  
**SUMMARY OF PERMEABILITY TESTS**

**TABLE II**

Company Deep Rock Oil Corporation Lease Engel Well No. K-11

Depth Interval Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity, Ft. x Md.
387.38 - 395.02	7.42	29.60	219.61
395.08 - 400.29	4.13	12.00	49.56
387.38 - 400.29	11.55	23.30	269.17

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RESULTS OF SATURATION TESTS

TABLE III

Company Deep Rock Oil Corporation Lease Engel Well No. 3-11

Sat. No.	Depth, Feet	Effective Porosity Percent	Percent Saturation		Oil Content, Bbls./A. Ft.	Feet of Core		Total Oil Content Bbls./Acre
			Oil	Water		Ft.	Cum. Ft.	
1	387.75	17.3	42.7	38.4	573	0.82	0.82	470
2	388.56	18.1	41.4	39.3	581	1.20	2.02	697
3	390.14	17.9	40.6	36.0	565	1.20	3.22	678
4	391.03	16.8	41.6	34.9	528	1.20	4.42	634
5	391.96	17.8	42.1	37.3	582	1.00	5.42	582
6	393.29	18.2	41.4	35.6	586	1.00	6.42	586
7	394.40	19.0	42.5	41.6	626	1.22	7.64	765
9	395.45	18.2	44.7	29.2	631	0.97	8.61	613
10	396.50	18.2	46.7	37.8	659	0.80	9.41	527
11	397.57	16.4	42.4	33.3	540	0.74	10.15	400
12	398.36	17.0	44.6	39.8	589	0.60	10.75	353
13	399.40	15.7	44.9	38.4	548	1.22	11.97	669
14	400.03	14.7	48.1	34.6	549	0.34	12.31	187
						Total	-- --	7,161

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SUMMARY OF SATURATION TESTS

TABLE IV

Company	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
Deep Rock Oil Corporation	387.38 - 395.02	7.64	17.81	41.71	37.62	577	4,432
	395.08 - 400.29	4.67	16.88	44.99	35.46	589	2,749
	387.38 - 400.29	12.31	17.50	42.97	36.80	582	7,161

Lease Engel

Well No. I-11

Oil Field Research

RESULTS OF LABORATORY

TABLE

Company Deep Rock Oil Corporation

Lease Engel

Sample No.	Depth, Feet	Effective Porosity Percent	Original Oil Saturation		Oil Recovery	
			Percent	Bbls./A. Ft.	Percent	Bbls./A. Ft.
1	387.50	17.3	43.1	578	7.1	95
2	388.90	18.3	42.1	597	14.3	213
3	389.85	18.5	41.3	592	9.9	142
4	391.33	16.0	41.7	517	7.8	97
5	392.35	17.7	41.8	574	4.9	67
6	393.09	17.5	41.5	564	4.8	65
7	394.15	18.9	41.9	614	7.1	104
9	395.74	17.7	43.1	591	7.9	108
10	396.70	18.6	46.1	665	8.4	121
11	397.72	16.8	43.0	560	5.4	70
12	398.44	16.5	43.6	559	4.9	63
13	399.20	15.7	45.1	550	0.0	0
14	400.23	14.4	47.7	532	0.0	0

Notes: cc - cubic centimeter  
 \*Volume of water recovered at the time of maximum recovery  
 \*\*Determined by passing water through sample

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RESULTS OF LABORATORY FLOODING TESTS

TABLE V

Lease Engel Well No. K-11

Recovery	Residual Saturation			Volume of Water Recovered cc*	Effective Permeability, Millidarcys **	Initial Fluid Production Pressure Lbs./Sq. In.
	Bbls./A. Ft.	% Oil	% Water			
95	36.0	56.7	483	10	0.274	30
213	27.8	61.6	394	28	0.883	20
142	31.4	59.1	450	17	0.495	25
97	33.9	56.8	421	6	0.185	30
67	36.9	50.0	507	7	0.277	35
65	36.7	52.5	499	6	0.287	40
104	34.8	62.0	510	60	1.980	25
108	35.2	58.3	483	16	0.462	25
121	37.7	57.7	544	19	0.478	25
70	37.6	59.8	490	10	0.280	30
63	38.7	54.0	496	5	0.183	40
0	45.1	42.1	550	0	Imp.	50 <sup>+</sup>
0	47.7	40.2	532	0	Imp.	50 <sup>+</sup>

time of maximum oil recovery.  
 enough sample which still contains residual oil.

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## SUMMARY OF LABORATORY FLOODING TESTS

TABLE VI

Company	Lease	Engel	Well No.
Deep Rock Oil Corporation	397.38 - 395.02	395.08 - 398.50	K-11
Depth Interval, Feet	7.64	3.11	10.75
Feet of Core Analyzed	17.79	17.89	17.71
Average Percent Porosity	61.90	43.96	42.51
Average Percent Original Oil Saturation	8.20	6.85	7.82
Average Percent Oil Recovery	33.70	37.11	34.69
Average Percent Residual Oil Saturation	57.32	57.72	57.43
Average Percent Residual Water Saturation	91.02	94.83	92.12
Average Percent Total Residual Fluid Saturation	579.	597.	584.
Average Original Oil Content, Bbls./A. Ft.	113.	94.	109.
Average Oil Recovery, Bbls./A. Ft.	464.	503.	475.
Average Residual Oil Content, Bbls./A. Ft.	4,422.	1,856.	6,278.
Total Original Oil Content, Bbls./Acre	879.	292.	1,171.
Total Oil Recovery, Bbls./Acre	3,543.	1,564.	5,107.
Total Residual Oil Content, Bbls./Acre	0.666	0.369	0.580
Average Effective Permeability, Millidarcys	29.3	30.0	29.6
Average Initial Fluid Production Pressure, p.s.i.			

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 Well No. K-11

Sample No.	Depth, Feet	Chloride Content of Brine in Sand ppm	Percent Water Saturation		
			Connate	Drilling & Foreign	Total
1	387.75	13,100			
2	388.56	15,000			
3	390.14	14,700			
4	391.05	13,800			
5	391.96	14,500			
6	393.29	15,600			
7	394.40	14,700			
9	395.45	15,200			
10	396.50	14,300			
11	397.57	13,100			
12	398.36	14,600			
13	399.40	14,700			
14	400.03	14,500			

Note: ppm - parts per million

**Oil Field Research Laboratories**

**SUMMARY OF WATER DIFFERENTIATION TESTS**

**TABLE VIII**

Company Deep Eack Oil Corporation Lease Engel Well No. K-11

<u>Depth Interval, Feet</u>	<u>Chloride Content of Brine in Sand, ppm</u>	<u>Average Percent Connate Water</u>	<u>Average Percent Drilling &amp; Foreign Water</u>
387.38 - 395.02	14,784		
395.08 - 400.29	14,448		
387.38 - 400.29	14,656		

**Note: ppm - parts per million**