

December 15, 1950

Deep Rock Oil Corporation
Atlas Life Building
Tulsa, Oklahoma

Attention: Mr. T. F. Leury

Gentlemen:

Enclosed herewith is the report of the analysis made on the 2½" rotary core taken from the Engel Lease, Well No. I-9, Crawford County, Kansas, and submitted to our laboratory on November 27, 1950.

Very truly yours,

OIL FIELD RESEARCH LABORATORIES

Carl L. Fata

CLP:em

c.c. to Mr. Neil Henderson

DEEP ROCK OIL CORPORATION
CORE ANALYSIS REPORT
ENGEL LEASE WELL NO. 1-9
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. L-9

Location NE4

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

Name of Sand	Barfleeville
Top of Core	377.57
Bottom of Core	396.20
Top of Sand Bar	386.00
Bottom of Sand	395.00
Total Feet of Permeable Sand	10.60

Distribution of Permeable Sand: Permeability Range Millidarcys	Feet	Cum. Ft.
0. - 4	1.85	1.85
4. - 8	0.80	2.65
8 - 12	2.10	4.75
12 - 24	2.75	7.50
24 - 48	0.70	8.20
48 & above	2.40	10.60

Average Permeability Millidarcys	23.20
Average Percent Porosity	17.65
Average Percent Oil Saturation	41.59
Average Percent Water Saturation	34.35
Average Oil Content, Bbls./A. Ft.	570.
Total Oil Content, Bbls./Acre	6,045.
Average Percent Oil Recovery by Laboratory Flooding Tests	9.70
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	139.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	1,102.
Total Calculated Oil Recovery, Bbls./Acre	2,600.
Packer Setting, Feet	384.50
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	

The above averages are for that part of the sand section extending from the packer setting to the bottom of the sand.

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:

<u>Depth Interval,</u> <u>Feet</u>	<u>Description</u>
377.57 - 381.00	- According to log, very sandy shale (discarded at well).
381.00 - 381.45	- Gray sandy shale.
381.45 - 381.75	- Light brown fine grained laminated micaceous shaley sandstone.
381.75 - 382.00	- Light brown fine grained slightly laminated micaceous shaley sandstone.
382.00 - 382.17	- Light brown fine grained laminated micaceous shaley sandstone.
382.17 - 382.45	- Laminated sandy shale.
382.45 - 383.80	- Hard gray fine grained micaceous calcareous sandstone.
383.80 - 384.17	- Hard gray fine grained laminated micaceous shaley calcareous sandstone.
384.17 - 384.50	- Hard light brown fine grained micaceous calcareous shaley sandstone.
384.50 - 385.90	- Brown fine grained micaceous sandstone.
385.90 - 386.00	- Laminated sandstone and shale.
386.00 - 386.65	- Brown fine grained micaceous sandstone.
386.65 - 386.75	- Gray sandy shale.
386.75 - 387.30	- Brown fine grained micaceous sandstone.
387.30 - 387.50	- Brown fine grained slightly laminated micaceous shaley sandstone.
387.50 - 388.45	- Brown fine grained micaceous sandstone.
388.45 - 388.80	- Laminated sandy shale.
388.80 - 392.40	- Brown fine grained micaceous sandstone.

- 392.40 - 394.80 - Dark brown fine grained micaceous sandstone.
- 394.80 - 395.00 - Brown fine grained micaceous sandstone.
- 395.00 - 395.42 - Dark fine grained micaceous carbonaceous sandstone.
- 395.42 - 395.55 - Laminated sandy shale.
- 395.55 - 395.70 - Brown fine grained micaceous sandstone.
- 395.70 - 395.90 - Brown fine grained laminated micaceous shaley sandstone.
- 395.90 - 396.20 - Dark fine grained micaceous carbonaceous sandstone.

Coring was started at a depth of 377.57 feet in sandy shale and completed at 396.20 feet in fine grained micaceous carbonaceous sandstone. This core shows a total of 12.27 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 two sections. The weighted average permeability of the upper and lower sections are 9.64 and 34.01 millidarcys respectively while that of the pay sand, or that part of the cored section extending from the packer setting to the bottom of the sand, is 23.20 (See Table II). By observing the data given on the coregraph, it is noticeable that the sand has a very irregular permeability profile and that the lower part of the cored section has a considerably higher permeability.

PERCENT SATURATION & OIL CONTENT

The pay sand in this core shows a good weighted average percent oil saturation, namely, 41.59. The weighted average percent oil saturation of the upper and lower sections are 37.38 and 43.42 respectively. The weighted average percent water saturation of the upper and lower sections are 39.08 and 31.28 respectively while that of the pay sand is 34.35

(See Table IV). This gives an overall weighted average total fluid saturation of 75.94 percent. This comparatively low total fluid saturation indicates that an appreciable amount of fluid was lost during coring which was probably oil.

In order 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, thereby indicating 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 498 and 602 barrels per acre foot respectively while that of the pay sand is 570 barrels. The total oil content, as shown by this core, is 6,162 barrels per acre of which 5,045 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 1,102 barrels of oil per acre was obtained from 7.95 feet of sand. The weighted average percent oil saturation was reduced from 41.39 to 31.69, or represents an average recovery of 9.70 percent. The weighted average effective permeability of the samples is 0.454 millidarcys while the average initial fluid production pressure is 28.8 pounds per square inch (See Table VI). The tests show that the samples after flooding have a fairly high residual oil saturation.

By observing the data given in Table V, you will note that of the 11 samples tested, 8 produced oil and water. This indicates that most

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 2,600 barrels of oil per acre or an average of 304 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 was assumed that this well was drilled in virgin territory.

The principle drawback of this core is the fact that it contains only 8.55 feet of floodable sand and that the sand has a low average effective permeability for its depth.

Oil Field Research Laboratories

SHOT RECOMMENDATION

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

<u>Depth Interval, Feet</u>	<u>Feet of Sand</u>	<u>Size of Shell Inches</u>	<u>Qts./Ft.</u>	<u>Total Quarts</u>
388.5 - 394.5	6.0	4 $\frac{1}{2}$	3.1	18.6

Recommended Backer Setting 384.5 feet

Oil Field Research Laboratories
RESULTS OF PERMEABILITY TESTS
TABLE I

Company Deep Rock Oil Corporation Lease Angel Well No. I-9

Sample No.	Depth, Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
1	381.50	Imp.	0.30	0.30	0.00
2	381.78	Imp.	0.25	0.55	0.00
3	382.05	2.2	0.17	0.72	0.37
4	382.61	Imp.	0.30	1.02	0.00
5	382.95	Imp.	0.55	1.57	0.00
6	383.68	Imp.	0.50	2.07	0.00
7	384.00	Imp.	0.37	2.44	0.00
8	384.45	Imp.	0.33	2.77	0.00
9	385.10	3.8	0.80	3.57	3.04
10	385.45	6.7	0.30	3.87	2.61
11	385.85	2.1	0.30	4.17	0.63
12	386.30	13.	0.65	4.82	8.45
13	386.80	9.7	0.25	5.07	2.43
14	387.10	22.	0.30	5.37	6.60
15	387.40	7.8	0.20	5.57	1.56
16	388.00	21.	0.65	6.22	14.95
17	388.31	5.1	0.30	6.52	1.53
18	388.95	8.7	0.45	6.97	3.92
19	389.53	2.5	0.40	7.37	1.00
20	389.80	2.1	0.20	7.57	0.42
21	389.93	30.	0.45	8.02	13.50
22	390.65	21.	0.45	8.47	9.45
23	390.89	27.	0.25	8.72	6.75
24	391.13	9.7	0.40	9.12	3.88
25	391.75	14.	0.45	9.57	6.30
26	392.00	9.7	0.30	9.87	2.91
27	392.30	13.	0.25	10.12	3.25
28	392.95	68.	0.80	10.92	54.40
29	393.40	63.	0.55	11.47	34.65
30	394.03	55.	0.50	11.97	27.50
31	394.43	56.	0.55	12.52	30.80
32	395.08	8.6	0.40	12.92	3.44
33	395.65	1.3	0.15	13.07	0.20
34	396.14	6.0	0.30	13.37	1.80

Oil Field Research Laboratories

SUMMARY OF PERMEABILITY TESTS

TABLE II

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

<u>Depth Interval Feet</u>	<u>Feet of Core Analyzed</u>	<u>Average Permeability, Millidarcys</u>	<u>Permeability Capacity, Ft. x Md.</u>
381.45 - 389.80	4.92	9.64	47.41
389.80 - 396.20	5.85	34.01	198.93
384.50 - 396.20	10.60	23.20	245.97

Oil Field Research Laboratories

RESULTS OF SATURATION TESTS

TABLE III

Company Deep Rock Oil Corporation Lease Original Well No. I-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.	
F-1	361.64	14.0	15.9	-	173	0.30	0.30	52
1	361.90	13.6	24.5	64.0	289	0.25	0.55	53
3	364.62	16.9	33.1	48.0	408	1.40	1.95	571
4	366.47	16.9	40.1	29.4	589	0.65	2.60	362
5	367.60	16.3	42.1	36.2	600	1.70	4.30	1,020
6	369.30	16.5	43.0	33.3	651	1.00	5.30	531
7	390.42	16.3	44.3	29.6	629	1.05	6.35	660
8	391.32	17.1	39.4	36.6	523	1.55	7.90	810
9	392.78	16.3	42.9	28.0	610	0.80	8.70	488
10	393.86	16.2	47.3	27.8	670	1.00	9.70	670
11	394.70	16.9	49.6	26.6	714	0.60	10.30	428
F11	394.90	17.1	44.1	-	585	0.20	10.50	117
F12	395.80	15.6	35.1	-	425	0.35	10.85	149
12	396.00	16.4	46.4	35.5	664	0.30	11.15	199
					Total	Total	- - -	6,162

Oil Field Research Laboratories

SUMMARY OF SATURATION TESTS

TABLE IV

Company	Deep Rock Oil Corporation	Lease	Angel	Well No.	1-9	
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
381.45-389.80	5.30	17.20	37.32	32.00	492	2,641
389.80-396.20	5.85	17.89	43.42	31.28	602	3,321
384.50-396.20	10.60	17.65	41.59	34.35	570	6,045

Oil Field Research Laboratories
RESULTS OF LABORATORY FLOODING TESTS

TABLE V

Company Deep Rock Oil Corporation Lease Engel Well No. I-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	381.64	14.0	15.9	173	0.0	0	15.9	65.8	173	0	Imp.	50 7
3	384.88	15.2	34.2	403	0.0	0	34.2	50.0	403	0	Imp.	50 7
4	386.11	18.1	41.0	577	9.6	135	31.4	59.2	442	8	0.183	30
5	387.82	18.9	40.1	589	11.0	162	29.1	57.4	427	14.5	0.338	20
6	389.10	17.3	42.6	572	10.2	137	32.4	59.2	435	2	0.191	30
7	390.07	18.8	43.6	636	10.9	159	32.7	66.4	477	18	0.600	20
8	391.58	17.3	37.8	509	5.7	77	32.1	61.9	432	6	0.193	35
9	392.52	18.3	41.0	483	9.2	131	31.8	60.5	452	19	0.390	25
10	393.60	18.7	45.7	665	14.3	208	31.4	62.0	457	49	1.46	20
11	394.90	17.1	44.1	585	0.9	12	43.2	46.0	573	1	0.099	50
12	395.80	15.6	35.1	425	0.0	0	35.1	47.7	425	0	Imp.	50 7

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	Lease	Well No.
Deep Rock Oil Corporation	Ingal	1-9
Depth Interval, Feet	384.50 - 399.80	384.50 - 396.20
Feet of Core Analyzed	3.35	7.95
Average Percent Porosity	15.87	16.16
Average Percent Original Oil Saturation	41.02	41.39
Average Percent Oil Recovery	10.48	9.70
Average Percent Residual Oil Saturation	30.54	31.69
Average Percent Residual Water Saturation	58.27	60.44
Average Percent Total Residual Fluid Saturation	85.81	92.13
Average Original Oil Content, Bbls./A. Ft.	582.	586.
Average Oil Recovery, Bbls./A. Ft.	150.	139.
Average Residual Oil Content, Bbls./A. Ft.	432.	447.
Total Original Oil Content, Bbls./Acre	1,949.	4,655.
Total Oil Recovery, Bbls./Acre	501.	1,102.
Total Residual Oil Content, Bbls./Acre	1,448.	3,553.
Average Effective Permeability, Millidarcys	0.254	0.581
Average Initial Fluid Production Pressure, p.s.i.	26.7	30.0
		28.8

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. 1-9

Sample No.	Depth, Feet	Chloride Content of Brine in Sand ppm	Percent Water Saturation	
			Connate	Drilling & Foreign
			Total	
1	381.90	13,300		
3	384.62	11,200		
4	386.47	16,700		
5	387.60	13,300		
6	389.30	15,000		
7	390.42	12,900		
8	391.32	13,400		
9	392.78	15,000		
10	393.86	14,800		
11	394.70	14,200		
12	396.00	13,800		
	Note:	ppm - parts per million		

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SUMMARY OF WATER DIFFERENTIATION TESTS

TABLE VIII

Company Deep Rock Oil Corporation Lease Engel Well No. 1-29

<u>Depth Interval, Feet</u>	<u>Chloride Content of Brine in Sand, ppm</u>	<u>Average Percent Connate Water</u>	<u>Average Percent Drilling & Foreign Water</u>
381.45 - 389.80	13,500		
389.80 - 396.20	13,926		
384.50 - 396.20	13,730		

Note: ppm - parts per million