● CORE ANALYSIS ● WATER REPRESSURING ENGINEERING ● WATER ANALYSIS ● FLOODING WATER TREATMENT ● SURVEYING

OILFIELD RESEARCH LABORATORIES

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April 8, 1959

George Sheehan, et al
510 Thompson Building
Tulsa 3, Oklahoma

Gentlemen:

Enclosed herewith is the report of the analysis of the 2 7/8" Rotary core taken from the Ellis Lease, Well No. W-33, Greenwood County, Kansas, and submitted to our laboratory on April 2, 1959.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Carl L. McElrea

Carl L. McElrea

CLM:cs

4 c. to Mr. Harvey Culver
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Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company George Sheehan, et al Lease Ellis Well No. W-33

Location 1980' South of North Line on West Line

Section 27 Twp. 23S Rge. 11E County Greenwood State Kansas

Name of Sand	Bartlesville
Top of Core	1900.0
Bottom of Core	1940.0
Top of Oil Sand	1902.8
Bottom of Sand	1935.0
Total Feet of Permeable Sand	25.6
Total Feet of Floodable Sand	3.0

Distribution of Permeable Sand: Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 1.0	4.5	4.5
1.0 - 2.0	6.8	11.3
2.0 - 2.5	3.8	15.1
2.5 - 3.0	4.0	19.1
3.0 - 4.0	2.5	21.6
4.0 & above	4.0	25.6

Average Permeability Millidarcys	2.4
Average Percent Porosity	14.7
Average Percent Oil Saturation	24.5
Average Percent Water Saturation	50.0
Average Oil Content, Bbls./A. Ft.	279.
Total Oil Content, Bbls./Acre	9,411.
Average Percent Oil Recovery by Laboratory Flooding Tests	9.3
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	115.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	345.
Total Calculated Oil Recovery, Bbls./Acre	400.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

A fresh water mud was used as the circulating fluid during the coring of the sand.

This core was sampled and the samples were sealed in cans by a representative of our laboratory.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
1900.0 - 1902.8	Gray shaley sandstone.
1902.8 - 1932.1	Brownish gray laminated shaley slightly carbonaceous sandstone.
1932.1 - 1932.3	Laminated carbonaceous sandstone.
1932.3 - 1935.0	Brownish gray laminated shaley slightly carbonaceous sandstone.
1935.0 - 1935.6	Conglomeratic carbonaceous sandstone.
1935.6 - 1936.0	Gray shale.
1936.0 - 1940.0	Sandy shale.

Coring was started at a depth of 1900.0 feet in gray shaley sandstone and completed at 1940.0 feet in sandy shale. This core shows a total of 35.6 feet of sandstone. For the most part, the pay is made up of brownish gray laminated shaley slightly carbonaceous 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 is 1.1, 3.1 and 2.3 millidarcys respectively; the overall average being 2.4 (See Table III). By observing the data given on the core-graph, it is noticeable that the sand is tight. The permeability of the sand varies from 0.49 to a maximum of 7.9 millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a fairly low weighted average percent oil saturation, namely, 24.5. The weighted average percent oil saturation of the upper, middle and lower sections is 22.9, 26.7 and 23.6 respectively. The weighted average percent water saturation of the upper, middle and lower sections is 53.5, 46.1 and 51.4 respectively; the overall average being 50.0 (See Table III). This gives an overall weighted average total fluid saturation of 74.5 percent. This low total fluid saturation indicates considerable fluid was lost during coring, part of which probably was oil.

The weighted average oil content of the upper, middle and lower sections is 262, 302 and 266 barrels per acre foot respectively; the overall average being 279. The total oil content, as shown by this core, is 9,411 barrels per acre (See Table III).

LABORATORY FLOODING TESTS

The sand in this core did not respond too satisfactorily to laboratory flooding tests, as a total recovery of 345 barrels of oil per acre was obtained from 3.0 feet of sand. The weighted average percent oil saturation was reduced from 27.0 to 17.7, or represents an average recovery of 9.3 percent. The weighted average effective permeability of the samples is 0.744 millidarcys, while the average initial fluid production pressure is 35.0 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 34 samples tested, 3 produced water and oil. This indicates that approximately 9 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sand is for the most part rather tight.

CONCLUSION

On the basis of the enclosed data, it is evident that an efficient water-flood will recover an average of 133 barrels of oil per acre foot from the 3.0 feet of floodable pay sand analyzed, or a total of approximately 400 barrels of oil per acre from the area of which this core is representative. The following factors and assumptions were used in calculating this recovery:

Original formation volume factor	1.13
Present formation volume factor	1.03
True water saturation, percent	40.0
Primary oil recovery, percent	12.0
Calculated present oil saturation, percent	42.7
Porosity, percent	15.7
Oil saturation at abandonment, percent	20.0
Performance factor	0.50

This core shows a shaley and tight sand section having fairly low oil and rather high water saturations. The analysis results show 3.0 feet of floodable pay sand in the cored section.

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RESULTS OF PERMEABILITY TESTS

TABLE I

Company George Sheehan, et al Lease Ellis Well No. W-33

Sample No.	Depth Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
1	1901.2	Imp.	0.5	0.5	0.00
2	1901.7	Imp.	0.5	1.0	0.00
3	1902.9	Imp.	0.4	1.4	0.00
4	1903.4	Imp.	0.5	1.9	0.00
5	1903.9	Imp.	0.5	2.4	0.00
6	1904.4	Imp.	0.5	2.9	0.00
7	1904.9	Imp.	0.5	3.4	0.00
8	1905.4	Imp.	0.5	3.9	0.00
9	1905.9	Imp.	0.5	4.4	0.00
10	1906.4	Imp.	0.5	4.9	0.00
11	1906.9	1.7	0.5	5.4	0.85
12	1907.4	1.8	0.5	5.9	0.90
13	1907.9	0.72	0.5	6.4	0.36
14	1908.4	0.99	0.5	6.9	0.50
15	1908.9	0.91	0.5	7.4	0.45
16	1909.4	Imp.	0.5	7.9	0.00
17	1909.9	0.49	0.5	8.4	0.25
18	1910.4	Imp.	0.5	8.9	0.00
19	1910.9	1.1	0.5	9.4	0.55
20	1911.4	0.84	0.5	9.9	0.42
21	1911.9	Imp.	0.5	10.4	0.00
22	1912.4	0.96	0.5	10.9	0.48
23	1912.9	1.3	0.5	11.4	0.65
24	1913.4	0.77	0.5	11.9	0.38
25	1913.9	4.5	0.5	12.4	2.25
26	1914.4	Imp.	0.5	12.9	0.00
27	1914.9	0.69	0.5	13.4	0.35
28	1915.4	3.6	0.5	13.9	1.80
29	1915.9	2.1	0.5	14.4	1.05
30	1916.4	1.3	0.5	14.9	0.65
31	1916.9	Imp.	0.5	15.4	0.00
32	1917.4	4.6	0.5	15.9	2.30
33	1917.9	3.5	0.5	16.4	1.75
34	1918.4	1.7	0.5	16.9	0.85
35	1918.9	1.8	0.5	17.4	0.90
36	1919.4	0.95	0.5	17.9	0.47
37	1919.9	2.1	0.5	18.4	1.05
38	1920.4	2.5	0.5	18.9	1.25
39	1920.9	2.6	0.5	19.4	1.30
40	1921.4	5.5	0.5	19.9	2.75

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RESULTS OF PERMEABILITY TESTS

TABLE I

Company George Sheehan, et al Lease Ellis Well No. W-33

Sample No.	Depth Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
41	1921.9	5.3	0.5	20.4	2.65
42	1922.4	2.3	0.5	20.9	1.15
43	1922.9	2.2	0.5	21.4	1.10
44	1923.4	3.4	0.5	21.9	1.70
45	1923.9	3.9	0.5	22.4	1.95
46	1924.4	1.5	0.5	22.9	0.75
47	1924.9	1.4	0.5	23.4	0.70
48	1925.4	4.2	0.5	23.9	2.10
49	1925.9	7.9	0.5	24.4	3.95
50	1926.4	5.9	0.5	24.9	2.95
51	1926.9	2.1	0.5	25.4	1.05
52	1927.4	1.0	0.5	25.9	0.50
53	1927.9	4.4	0.5	26.4	2.20
54	1928.4	2.6	0.5	26.9	1.30
55	1928.9	1.1	0.5	27.4	0.55
56	1929.4	2.2	0.5	27.9	1.10
57	1929.9	2.7	0.5	28.4	1.35
58	1930.4	2.3	0.5	28.9	1.15
59	1930.9	2.7	0.5	29.4	1.35
60	1931.4	2.7	0.5	29.9	1.35
61	1931.8	1.1	0.4	30.3	0.44
62	1932.4	1.5	0.4	30.7	0.60
63	1932.9	1.2	0.5	31.2	0.60
64	1933.4	2.5	0.5	31.7	1.25
65	1933.9	3.4	0.5	32.2	1.70
66	1934.4	2.6	0.5	32.7	1.30
67	1934.9	2.0	0.3	33.0	0.60

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RESULTS OF SATURATION TESTS

TABLE II

Company George Sheehan, et al Lease Ellis Well No. W-33

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	1901.5	13.4	8	75	83	83	1.0	1.0	83
2	1903.1	15.6	23	54	77	279	0.8	1.8	223
3	1904.1	14.7	25	57	82	286	1.0	2.8	286
4	1905.1	14.2	23	57	80	254	1.0	3.8	254
5	1906.1	14.9	14	56	70	162	1.0	4.8	162
6	1907.1	15.3	29	44	73	344	1.0	5.8	344
7	1908.1	14.6	25	49	74	283	1.0	6.8	283
8	1909.1	14.1	31	55	86	339	1.0	7.8	339
9	1910.1	14.2	23	50	73	254	1.0	8.8	254
10	1911.1	14.8	27	50	77	310	1.0	9.8	310
11	1912.1	15.0	21	50	71	244	1.0	10.8	244
12	1913.1	15.2	26	44	70	307	1.0	11.8	307
13	1914.1	14.4	30	40	70	335	1.0	12.8	335
14	1915.1	14.9	27	51	78	312	1.0	13.8	312
15	1916.1	14.2	27	43	70	298	1.0	14.8	298
16	1917.1	14.1	27	62	89	296	1.0	15.8	296
17	1918.1	15.2	33	39	72	389	1.0	16.8	389
18	1919.1	15.4	26	41	67	310	1.0	17.8	310
19	1920.1	14.1	19	47	66	208	1.0	18.8	208
20	1921.1	16.4	22	47	69	280	1.0	19.8	280
21	1922.1	15.1	25	42	67	293	1.0	20.8	293
22	1923.1	15.7	29	50	79	353	1.0	21.8	353
23	1924.1	14.5	27	43	70	304	1.0	22.8	304
24	1925.1	14.6	23	45	68	260	1.0	23.8	260
25	1926.1	15.7	32	49	81	290	1.0	24.8	290

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RESULTS OF SATURATION TESTS

TABLE II

Company George Sheehan, et al Lease Ellis Well No. W-33

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.	
26	1927.1	15.0	18	47	65	210	1.0	25.8	210
27	1928.1	14.1	27	54	81	296	1.0	26.8	296
28	1929.1	14.4	21	49	70	235	1.0	27.8	235
29	1930.1	14.6	24	46	70	272	1.0	28.8	272
30	1931.1	15.0	29	55	84	338	1.0	29.8	338
F-31	1932.0	15.8	18	-	-	221	0.5	30.3	111
31	1932.2	14.5	27	48	75	304	0.2	30.5	61
32	1933.1	14.2	25	48	73	276	1.3	31.8	359
33	1934.1	14.7	24	49	73	274	1.4	33.2	384
34	1935.1	13.1	21	75	96	214	0.6	33.8	128
							Total- - - - - - -		-9,411

Oilfield Research Laboratories

SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company George Sheehan, et al Lease Ellis Well No. W-33

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
1906.7 - 1913.6	5.4	1.1	5.72
1913.6 - 1926.6	12.0	3.1	37.20
1926.6 - 1935.0	8.2	2.3	18.98
1906.7 - 1935.0	25.6	2.4	61.90

Depth Interval, Feet	Feet of Core Analyzed	Average Percent Porosity	Average Percent Oil Saturation	Average Percent Water Saturation	Average Oil Content Bbl./A. Ft.	Total Oil Content Bbls./Acre
1901.0 - 1913.6	11.8	14.6	22.9	53.5	262	3,089
1913.6 - 1926.6	13.0	14.9	26.7	46.1	302	3,928
1926.6 - 1935.6	9.0	14.5	23.6	51.4	266	2,394
1901.0 - 1935.6	33.8	14.7	24.5	50.0	279	9,411

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company George Sheehan, et al Lease Ellis Well No. W-33

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.
			%	Bbls./A. Ft.	%	Bbls./A. Ft.	% Oil	% Water	Bbls./A. Ft.			
1	1901.5	13.8	5	54	0	0	5	85	54	0	Imp.	50+
2	1903.1	15.2	21	248	0	0	21	64	248	0	Imp.	50+
3	1904.1	14.2	22	243	0	0	22	63	243	0	Imp.	50+
4	1905.1	14.0	22	239	0	0	22	60	239	0	Imp.	50+
5	1906.1	14.6	12	136	0	0	12	60	136	0	Imp.	50+
6	1907.1	15.6	26	315	0	0	26	61	315	0	Imp.	50+
7	1908.1	15.1	22	258	0	0	22	61	258	0	Imp.	50+
8	1909.1	14.1	29	318	0	0	29	63	318	0	Imp.	50+
9	1910.1	14.2	22	242	0	0	22	62	242	0	Imp.	50+
10	1911.1	15.1	24	281	0	0	24	58	281	0	Imp.	50+
11	1912.1	14.9	20	231	0	0	20	60	231	0	Imp.	50+
12	1913.1	15.8	24	294	0	0	24	63	294	0	Imp.	50+
13	1914.1	14.8	27	310	0	0	27	52	310	0	Imp.	50+
14	1915.1	15.5	24	289	0	0	24	69	289	0	Imp.	50+
15	1916.1	14.5	26	293	0	0	26	56	293	0	Imp.	50+
16	1917.1	14.3	27	300	7	78	20	70	222	49	1.55	20
17	1918.1	15.5	34	410	0	0	34	47	410	0	Imp.	50+
18	1919.1	15.1	23	269	0	0	23	62	269	0	Imp.	50+
19	1920.1	14.4	17	190	0	0	17	68	190	0	Imp.	50+
20	1921.1	16.7	22	285	7	91	15	73	194	8	0.382	40
21	1922.1	14.8	22	253	0	0	22	67	253	0	Imp.	50+
22	1923.1	15.6	27	327	0	0	27	63	327	0	Imp.	50+
23	1924.1	14.3	25	278	0	0	25	60	278	0	Imp.	50+
24	1925.1	14.5	20	225	0	0	20	75	225	0	Imp.	50+
25	1926.1	16.2	32	402	14	176	18	77	226	14	0.300	45

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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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company George Sheehan, et al Lease Ellis Well No. W-33

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.
			%	Bbls./A. Ft.	%	Bbls./A. Ft.	% Oil	% Water	Bbls./A. Ft.			
26	1927.1	15.4	18	215	0	0	18	62	215	0	Imp.	50+
27	1928.1	14.6	25	283	0	0	25	67	283	0	Imp.	50+
28	1929.1	15.0	20	233	0	0	20	66	233	0	Imp.	50+
29	1930.1	14.6	22	249	0	0	22	64	249	0	Imp.	50+
30	1931.1	14.6	27	306	0	0	27	65	306	0	Imp.	50+
31	1932.0	15.8	18	221	0	0	18	70	221	0	Imp.	50+
32	1933.1	14.7	22	251	0	0	22	58	251	0	Imp.	50+
33	1934.1	14.5	21	236	0	0	21	68	236	0	Imp.	50+
34	1935.1	13.2	19	194	0	0	19	73	194	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.

Oilfield Research Laboratories

SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company George Sheehan, et al Lease Ellis Well No. W-33

Depth Interval, Feet	1916.6 - 1926.6
Feet of Core Analyzed	3.0
Average Percent Porosity	15.7
Average Percent Original Oil Saturation	27.0
Average Percent Oil Recovery	9.3
Average Percent Residual Oil Saturation	17.7
Average Percent Residual Water Saturation	73.3
Average Percent Total Residual Fluid Saturation	91.0
Average Original Oil Content, Bbls./A. Ft.	329.
Average Oil Recovery, Bbls./A. Ft.	115.
Average Residual Oil Content, Bbls./A. Ft.	214.
Total Original Oil Content, Bbls./Acre	987.
Total Oil Recovery, Bbls./Acre	345.
Total Residual Oil Content, Bbls./Acre	642.
Average Effective Permeability, Millidarcys	0.744
Average Initial Fluid Production Pressure, p.s.i.	35.0

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