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

OILFIELD RESEARCH LABORATORIES

- REGISTERED ENGINEERS -

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May 12, 1961

Mr. Lance C. Hill
Box 506
Emporia, Kansas

Dear Sir:

Enclosed herewith is the report of the analysis of the Rotary core taken from the E.T. Miller Lease, Well No. 1-C, Greenwood County, Kansas, and submitted to our laboratory on May 7, 1961.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Benjamin R. Pearman

Benjamin R. Pearman

BRP:db

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GENERAL INFORMATION & SUMMARY

Company Lance C. Hill Lease E.T. Miller Well No. 1-C

Location NE NE SE

Section 27 Twp. 23S Rge. 10E County Greenwood State Kansas

Name of Sand	Bartlesville
Top of Core	2257.0
Bottom of Core	2301.0
Top of Sand	2257.0
Bottom of Sand	2300.0
Total Feet of Permeable Sand	25.0
Total Feet of Floodable Sand	23.1

Distribution of Permeable Sand: Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 10	7.5	7.5
10 - 50	7.7	15.2
50 - 100	3.0	18.2
100 - 200	5.6	23.8
200 & above	1.2	25.0

Average Permeability Millidarcys	59.0
Average Percent Porosity	18.3
Average Percent Oil Saturation	33.0
Average Percent Water Saturation	36.4
Average Oil Content, Bbls./A. Ft.	471.
Total Oil Content, Bbls./Acre	12,793.
Average Percent Oil Recovery by Laboratory Flooding Tests	9.7
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	147.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	3,388.
Total Calculated Oil Recovery, Bbls./Acre - Primary and Secondary -	9,100.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

This core was taken with a rotary core barrel using fresh water mud as the circulating fluid. The well was drilled in virgin territory. The core was sampled and the samples sealed in cans by a representative of Oilfield Research Laboratories.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
2257.0 - 2260.6	Brown slightly shaley sandstone.
2260.6 - 2264.0	Alternate layers of sandstone and shale.
2264.0 - 2272.0	Brown sandstone.
2272.0 - 2272.4	Sandy shale.
2272.4 - 2280.0	Brown sandstone.
2280.0 - 2281.0	Alternate layers of sandstone and shale.
2281.0 - 2283.5	Brown sandstone.
2283.5 - 2290.5	Laminated sandy shale.
2290.5 - 2292.6	Brown laminated shaley sandstone.
2292.6 - 2293.3	Sandy shale.
2293.3 - 2295.7	Brown laminated shaley sandstone.
2295.7 - 2296.0	Shale.
2296.0 - 2297.3	Light brown shaley sandstone.
2297.3 - 2297.7	Sandy shale.
2297.7 - 2300.0	Grayish light brown calcareous sandstone.
2300.0 - 2301.0	Loss.

Coring was started at a depth of 2257.0 feet in slightly shaley sandstone and completed at 2301.0 feet in calcareous sandstone. This core shows a total of 25.0 feet of sandstone. For the most part, the pay is made up of brown 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 5.5, 78.9 and 7.1 millidarcys respectively; the overall average being 59.0 (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has a rather irregular permeability profile. The permeability of the sand varies from Impermeable to a maximum of 285 millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a fair weighted average percent oil saturation, namely, 33.0. The weighted average percent oil saturation of the upper, middle and lower sections is 37.6, 34.4 and 25.4 respectively. The weighted average percent water saturation of the upper, middle and lower sections is 35.6, 32.8 and 49.5 respectively; the overall average being 36.4 (See Table III). This gives an overall weighted average total fluid saturation of 69.4 percent. This low total fluid saturation indicates considerable fluid was lost during coring most of which was probably oil.

The weighted average oil content of the upper, middle and lower sections is 483, 522 and 298 barrels per acre foot respectively; the overall average being 471. The total oil content, as shown by this core, is 12,793 barrels per acre (See Table III).

LABORATORY FLOODING TESTS

The sand in this core responded rather well to laboratory flooding tests, as a total recovery of 3,388 barrels of oil per acre was obtained from 23.1 feet of sand. The weighted average percent oil saturation was reduced from 34.5 to 24.8, or represents an average recovery of 9.7 percent. The weighted average effective permeability of the samples is 11.11 millidarcys, while the average initial fluid production pressure is 13.3 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 28 samples tested, 24 produced water and 23 oil. This indicates that approximately 82 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sand has a wide variation in effective permeability to water.

CONCLUSION

Based on the results of the laboratory tests, it appears that approximately 9,100 barrels of oil per acre could be recovered from the area in the vicinity of this well by efficient primary and secondary methods. This includes a primary recovery of 4,400 barrels per acre and a secondary recovery of 4,700 barrels per acre. The following data and assumptions were used in calculating the above values:

Formation volume factor	1.21
Reservoir water saturation, percent	25.0
Average porosity, percent	18.8
Oil saturation after flooding, percent	24.8
Performance factor, percent	55.0
Net floodable pay sand, feet	23.1
A.P.I. gravity, reported	41.0

This core shows a good sand section having a fair oil saturation, a moderate water saturation and a good effective permeability to water. No difficulty should be encountered in obtaining satisfactory injection rates.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company Lance C. Hill Lease E.T. Miller Well No. 1-C

Sample No.	Depth, Feet	Effective Porosity Percent	Percent Saturation			Oil Content Bbls. / A Ft.	Perm., Mill.	Feet of Sand		Total Oil Content	Perm. Capacity Ft. X md.
			Oil	Water	Total			Ft.	Cum. Ft.		
1	2257.1	15.3	34	40	74	404	4.3	0.6	0.6	242	2.58
2	2258.1	14.2	43	34	77	474	4.8	1.0	1.6	474	4.80
3	2259.1	17.8	37	37	74	512	5.5	1.0	2.6	512	5.50
4	2260.1	18.8	35	33	68	510	7.0	1.0	3.6	510	7.00
5	2264.1	20.0	34	38	72	528	156.	0.6	4.2	316	93.60
6	2265.1	18.6	31	38	69	447	111.	1.0	5.2	447	111.00
7	2266.1	21.9	23	42	65	391	120.	1.0	6.2	391	120.00
8	2267.1	21.2	20	39	59	329	101.	1.0	7.2	329	101.00
9	2268.1	20.3	33	31	64	520	7.1	1.0	8.2	520	7.10
10	2269.1	21.5	33	32	65	551	87.	1.0	9.2	551	87.00
11	2270.1	21.4	34	31	65	564	55.	1.0	10.2	564	55.00
12	2271.1	20.9	33	37	70	535	47.	1.4	11.6	749	65.80
13	2273.1	21.6	48	22	70	804	285.	1.2	12.8	965	342.00
14	2274.1	14.7	29	40	69	331	6.3	1.0	13.8	331	6.30
15	2275.1	15.2	42	32	74	495	126.	1.0	14.8	495	126.00
16	2276.1	18.1	38	29	67	534	133.	1.0	15.8	534	133.00
17	2277.1	18.9	30	26	56	440	21.	1.0	16.8	440	21.00
18	2278.1	18.3	28	37	65	398	19.	1.0	17.8	398	19.00
19	2279.1	19.8	44	28	72	676	25.	1.4	19.2	945	35.00
20	2281.1	18.8	39	31	70	569	25.	0.6	19.8	341	15.00
21	2282.1	19.8	36	32	68	553	54.	1.0	20.8	553	54.00
22	2283.1	20.8	40	30	70	646	40.	0.9	21.7	581	36.00
23	2291.1	14.9	21	52	73	243	Imp.	1.1	22.8	267	0.00
24	2292.1	15.1	33	53	86	387	Imp.	1.0	23.8	387	0.00
25	2296.1	15.0	23	50	73	268	4.2	0.6	24.4	161	2.52
26	2297.1	15.4	28	43	71	335	1.3	0.7	25.1	234	0.91
27	2298.1	14.5	19	51	70	214	7.9	0.6	25.7	129	4.74
28	2299.1	15.1	26	47	73	305	11.	1.4	27.1	427	15.40

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company Lance C. Hill Lease E.T. Miller Well No. 1-C

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
2257.0 - 2260.6	3.6	5.5	19.88
2264.0 - 2283.5	18.1	78.9	1427.80
2290.5 - 2300.0	3.3	7.1	23.57
2257.0 - 2300.0	25.0	59.0	1471.25

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
2257.0 - 2260.6	3.6	16.7	37.6	35.6	483	1,738
2264.0 - 2283.5	18.1	19.6	34.4	32.8	522	9,450
2290.5 - 2300.0	5.4	15.1	25.4	49.5	298	1,605
2257.0 - 2300.0	27.1	18.3	33.0	36.4	471	12,793

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company Lance C. Hill Lease E.T. Miller Well No. 1-C

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	2257.1	15.4	34	406	7	84	27	64	322	21	0.500	15
2	2258.1	14.4	43	480	5	56	38	56	424	19	0.500	20
3	2259.1	17.6	37	504	10	136	27	62	368	19	0.500	20
4	2260.1	18.4	35	499	14	200	21	67	299	81	2.30	10
5	2264.1	20.2	34	532	10	156	24	69	376	1048	44.00	10
6	2265.1	18.9	31	454	10	147	21	68	307	38	1.10	15
7	2266.1	21.6	23	385	9	151	14	66	234	72	1.50	15
8	2267.1	20.0	20	310	3	47	17	59	263	152	3.70	10
9	2268.1	20.1	33	514	13	202	20	66	312	84	2.20	15
10	2269.1	21.3	33	545	17	281	16	70	264	212	6.40	10
11	2270.1	20.8	34	549	11	178	23	66	371	33	0.900	15
12	2271.1	21.0	33	537	8	130	25	67	407	300	14.70	10
13	2273.1	21.4	48	796	22	365	26	61	431	391	25.00	5
14	2274.1	15.1	29	340	2	23	27	61	317	86	2.20	15
15	2275.1	16.0	42	521	6	74	36	61	447	646	76.50	5
16	2276.1	18.3	38	539	13	185	25	63	354	404	40.80	5
17	2277.1	19.0	30	442	3	44	27	66	398	40	2.12	20
18	2278.1	18.5	28	401	4	57	24	64	344	37	1.10	15
19	2279.1	19.9	44	679	17	262	27	61	417	65	1.40	10
20	2281.1	18.4	39	556	10	143	29	59	413	13	0.333	25
21	2282.1	19.6	36	547	11	167	25	68	380	71	1.80	10
22	2283.1	20.6	40	639	12	192	28	70	447	164	5.00	15
23	2291.1	14.8	23	264	0	0	23	52	264	0	Imp.	50+
24	2292.1	15.0	31	361	0	0	31	56	361	0	Imp.	50+
25	2296.1	14.8	20	230	0	0	20	54	230	0	Imp.	50+
26	2297.1	15.6	30	363	0	0	30	48	363	0	Imp.	50+
27	2298.1	14.8	20	230	0	0	20	64	230	21	0.600	25
28	2299.1	15.3	26	308	3	36	23	70	272	135	4.40	15

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 V

Company Lance C. Hill Lease E. T. Miller Well No. 1-C

Depth Interval, Feet	2257.0 - 2260.6	2264.0 - 2283.5	2290.5 - 2300.0	2257.0 - 2300.0
Feet of Core Analyzed	3.6	18.1	1.4	23.1
Average Percent Porosity	16.6	19.5	15.3	18.8
Average Percent Original Oil Saturation	37.6	34.4	26.0	34.5
Average Percent Oil Recovery	9.2	10.3	3.0	9.7
Average Percent Residual Oil Saturation	28.4	24.1	23.0	24.8
Average Percent Residual Water Saturation	62.0	64.8	70.0	64.6
Average Percent Total Residual Fluid Saturation	90.4	88.9	93.0	89.4
Average Original Oil Content, Bbls./A. Ft.	480.	522.	308.	503.
Average Oil Recovery, Bbls./A. Ft.	123.	160.	36.	147.
Average Residual Oil Content, Bbls./A. Ft.	357.	362.	272.	356.
Total Original Oil Content, Bbls./Acre	1,726.	9,438.	431.	11,595.
Total Oil Recovery, Bbls./Acre	442.	2,896.	50.	3,388.
Total Residual Oil Content, Bbls./Acre	1,284.	6,542.	381.	8,207.
Average Effective Permeability, Millidarcys	7.34	12.39	4.40	11.11
Average Initial Fluid Production Pressure, p.s.i.	16.3	12.5	15.0	13.3

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