

OILFIELD RESEARCH LABORATORIES

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December 12, 1959

Home-Stake Production Company
Philtower Building
Tulsa 3, Oklahoma

Attn: Mr. Dave Davies

Gentlemen:

Enclosed herewith is the report of the analysis of the 3½" Rotary core taken from the Keighley Unit, Well No. CT-1, Butler, County, Kansas, and submitted to our laboratory on November 22, 1959.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES



Carl L. Pate

CLP:cs

cc - Mr. Leon Veeder
Box 8
Cherryvale, Kansas

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company Home-Stake Production Company Lease Keighley Unit Well No. CT-1

Location 1370' E. of W. Line & 610' S. of N. Line

Section 22 Twp. 27S Rge. 7E County Butler State Kansas

Name of Sand - - - - - Bartlesville

Top of Core - - - - - 2702.5

Bottom of Core - - - - - 2756.5

Top of Sand - - - - - 2715.6

Pay
Bottom of Sand - - - - - 2737.7

Total Feet of Permeable Sand - - - - - 28.5

Total Feet of Floodable Sand - - - - - 16.7

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 5	10.1	10.1
5 - 10	3.8	13.9
10 - 20	5.2	19.1
20 - 30	3.4	22.5
30 - 50	3.5	26.0
50 & over	2.5	28.5

Average Permeability Millidarcys - - - - - 17.5

Average Percent Porosity - - - - - 16.5

Average Percent Oil Saturation - - - - - 17.6

Average Percent Water Saturation - - - - - 58.8

Average Oil Content, Bbls./A. Ft. - - - - - 226.

Total Oil Content, Bbls./Acre - - - - - 6,752.

Average Percent Oil Recovery by Laboratory Flooding Tests - - - - - 2.3

Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft. - - - - - 31.

Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre - - - - - 378.

Total Calculated Oil Recovery, Bbls./Acre - - - - - 2,300.

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.

Samples were taken from the core and sealed in cans by a representative of Oilfield Research Laboratories.

FORMATION CORED

The detailed log of the formation cored is as follows:

<u>Depth Interval, Feet</u>	<u>Description</u>
2702.5 - 2702.7	- Grayish light brown sandstone.
2702.7 - 2703.2	- Gray shaley sandstone.
2703.2 - 2705.0	- Grayish light brown slightly shaley sandstone containing a vertical fracture.
2705.0 - 2705.5	- Gray laminated sandstone and shale.
2705.5 - 2706.2	- Gray shaley sandstone containing a vertical fracture.
2706.2 - 2710.0	- Grayish light brown slightly shaley sandstone containing a vertical fracture.
2710.0 - 2713.1	- Gray laminated sandy shale.
2713.1 - 2714.5	- Brownish gray shaley sandstone.
2714.5 - 2715.0	- Sandy shale.
2715.0 - 2715.6	- Light brown shaley sandstone.
2715.6 - 2716.6	- Light brown slightly shaley sandstone.
2716.6 - 2717.0	- Brownish gray slightly shaley sandstone.
2717.0 - 2718.5	- Light brown slightly shaley sandstone.
2718.5 - 2719.0	- Light brown laminated carbonaceous sandstone.
2719.0 - 2723.5	- Light brown slightly laminated slightly carbonaceous sandstone.
2723.5 - 2723.7	- Gray laminated carbonaceous sandstone.
2723.7 - 2730.6	- Light brown slightly laminated slightly carbonaceous sandstone.
2730.6 - 2733.0	- Brownish gray laminated carbonaceous sandstone.
2733.0 - 2737.7	- Light brown sandstone.

2737.7 - 2738.5 - Gray sandy shale.

2738.5 - 2754.5 - Gray sandy shale (Discarded at well).

2754.5 - 2756.5 - Rotten shale (Discarded at well).

Coring was started at a depth of 2702.5 feet in grayish light brown sandstone and completed at 2756.5 feet in rotten shale. This core shows a total of 31.1 feet of sandstone. For the most part, the pay is made up of slightly shaley to 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 3.0, 21.9 and 22.0 millidarcys respectively; the overall average being 17.5 (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has an irregular permeability profile. The permeability of the sand varies from 0.46 to a maximum of 69 millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a low weighted average percent oil saturation, namely, 17.6. The weighted average percent oil saturation of the upper, middle and lower sections is 12.4, 20.9 and 16.3 respectively. The weighted average percent water saturation of the upper, middle and lower sections is 67.6, 56.2 and 56.4 respectively; the overall average being 58.8 (See Table III). This gives an overall weighted average total fluid saturation of 76.4 percent. This total fluid saturation indicates some fluid was lost during coring, part of which probably was oil.

The weighted average oil content of the upper, middle and lower sections is 156, 271 and 210 barrels per acre foot respectively; the overall average being 226. The total oil content, as shown by this core, is 6,752 barrels per acre (See Table III).

LABORATORY FLOODING TESTS

Part of the sand in this core responded fairly well to laboratory flooding tests, as a total recovery of 378 barrels of oil per acre was obtained from 12.1 feet of sand. The weighted average percent oil saturation was reduced from 21.3 to 19.0, or represents an average recovery of 2.3 percent. The weighted average effective permeability of the samples is 2.82 millidarcys, while the average initial fluid production pressure is 23.3 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 30 samples tested, 28 produced water and 12 oil. This indicates that approximately 40 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sand has a rather wide variation in effective permeability.

CONCLUSION

It is evident from the enclosed data that an efficient water-flood will recover approximately 2,300 barrels of oil per acre from the area of which this core is representative. This represents an average recovery of 138 barrels of oil per acre foot from the 16.7 feet of floodable pay sand analyzed. The following factors and assumptions were used in calculating this recovery:

Original formation volume factor	1.16
Present formation volume factor	1.03
True water saturation, percent	42.0
Primary oil recovery, percent	12.0
Calculated present oil saturation, percent	39.5
Porosity, percent	17.0
Oil saturation at abandonment, percent	20.0
Performance factor, percent	55.0

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This core shows a rather broken and shaley sand section having low oil and high water saturations. The analysis results show 16.7 feet of good floodable sand in the interval extending from 2715.6 to 2737.7 feet.

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RESULTS OF PERMEABILITY TESTS
TABLE I

Company Home-Stake Production Company Lease Keighley Unit Well No. CT-1

Sample No.	Depth Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
1	2702.6	28.	0.2	0.2	5.60
2	2703.0	Imp.	0.5	0.7	0.00
3	2703.4	1.6	0.5	1.2	0.80
4	2703.9	2.0	0.5	1.7	1.00
5	2704.4	2.7	0.5	2.2	1.35
6	2704.9	4.0	0.3	2.5	1.20
7	2706.4	4.1	0.5	3.0	2.05
8	2706.9	4.5	0.5	3.5	2.25
9	2707.4	2.0	0.5	4.0	1.00
10	2707.9	Imp.	0.5	4.5	0.00
11	2708.4	0.89	0.5	5.0	0.45
12	2708.9	2.7	0.5	5.5	1.35
13	2709.4	2.6	0.5	6.0	1.30
14	2709.9	Imp.	0.3	6.3	0.00
15	2713.7	0.61	0.5	6.8	0.31
16	2714.3	0.46	0.5	7.3	0.23
17	2715.3	1.6	0.6	7.9	0.96
18	2715.8	12.	0.5	8.4	6.00
19	2716.4	19.	0.5	8.9	0.95
20	2716.9	6.7	0.4	9.3	2.68
21	2717.4	28.	0.7	10.0	19.60
22	2717.9	53.	0.5	10.5	26.50
23	2718.4	69.	0.3	10.8	20.70
24	2718.9	29.	0.5	11.3	14.50
25	2719.4	58.	0.7	12.0	40.60
26	2719.9	16.	0.5	12.5	8.00
27	2720.4	22.	0.5	13.0	11.00
28	2720.9	9.2	0.5	13.5	4.60
29	2721.4	17.	0.5	14.0	8.50
30	2721.9	58.	0.5	14.5	29.00
31	2722.4	39.	0.5	15.0	19.00
32	2722.9	37.	0.5	15.5	18.50
33	2723.4	4.9	0.3	15.8	1.47
34	2723.9	13.	0.5	16.3	6.50
35	2724.4	7.7	0.5	16.8	3.85
36	2724.9	15.	0.5	17.3	7.50
37	2725.4	24.	0.5	17.8	12.00
38	2725.9	17.	0.5	18.3	8.50
39	2726.4	8.7	0.5	18.8	4.35
40	2726.9	7.1	0.5	19.3	3.55

Oilfield Research Laboratories
RESULTS OF PERMEABILITY TESTS
TABLE I

Company Home-Stake Production Company Lease Keighley Unit Well No. CT-1

Sample No.	Depth Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
41	2727.4	30.	0.5	19.8	15.00
42	2727.9	36.	0.5	20.3	18.00
43	2728.4	3.9	0.5	20.8	1.95
44	2728.9	4.7	0.5	21.3	2.35
45	2729.4	5.8	0.5	21.8	2.90
46	2729.9	6.1	0.5	22.3	3.05
47	2730.4	7.5	0.4	22.7	3.00
48	2730.9	0.53	0.6	23.3	0.32
49	2731.4	2.5	0.5	23.8	1.25
50	2731.9	2.6	0.5	24.3	1.30
51	2732.4	2.1	0.5	24.8	1.05
52	2732.9	3.0	0.3	25.1	0.90
53	2733.4	19.	0.7	25.8	13.30
54	2733.9	19.	0.5	26.3	9.50
55	2734.4	16.	0.5	26.8	8.00
56	2734.9	23.	0.5	27.3	11.50
57	2735.4	64.	0.5	27.8	32.00
58	2735.9	26.	0.5	28.3	13.00
59	2736.4	42.	0.5	28.8	21.00
60	2736.9	43.	1.0	29.8	43.00

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RESULTS OF SATURATION TESTS

TABLE II

Company Home-Stake Production Company Lease Keighley Unit Well No. CT-1

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	2702.8	15.0	3	90	35	0.5	0.5	18
2	2703.6	16.1	18	65	226	0.9	1.4	204
3	2704.6	15.3	16	71	190	0.9	2.3	171
4	2706.6	18.4	14	56	200	0.9	3.2	180
5	2707.6	16.3	12	68	152	1.0	4.2	152
6	2708.6	15.5	12	73	144	1.0	5.2	144
7	2709.6	16.0	16	59	199	0.9	6.1	179
8	2714.0	16.1	6	78	75	1.0	7.1	75
9	2715.5	16.9	10	65	131	0.6	7.7	79
F-9	2715.7	18.3	17	-	242	0.5	8.2	121
10	2716.5	18.1	23	-	323	0.5	8.7	162
11	2717.6	17.8	10	65	138	0.4	9.1	55
12	2718.6	18.2	22	56	312	1.5	10.6	468
13	2719.6	17.2	24	65	321	0.5	11.1	160
14	2720.6	19.2	21	48	314	1.1	12.2	345
15	2721.6	15.6	22	55	269	1.0	13.2	269
16	2722.6	17.3	25	51	322	1.0	14.2	322
17	2723.6	14.9	20	55	269	1.4	15.6	377
18	2724.6	15.0	9	68	104	0.2	15.8	21
19	2725.6	16.1	17	56	198	1.4	17.2	277
20	2726.6	14.0	19	57	238	1.0	18.2	238
21	2727.6	15.9	18	58	196	1.0	19.2	196
22	2728.6	15.2	25	48	309	1.0	20.2	309
23	2729.6	16.5	22	56	260	1.0	21.2	260
			25	57	321	1.0	22.2	321

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RESULTS OF SATURATION TESTS

TABLE II

Company Home-Stake Production Company Lease Keighley Unit Well No. CF-1

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.	
F-24	2730.5	17.5	23	71	312	0.5	22.7	156
24	2730.7	15.0	17	73	198	0.5	23.2	99
25	2731.6	15.4	11	66	131	1.0	24.2	131
26	2732.6	15.1	13	66	153	0.9	25.1	138
27	2733.6	15.4	16	49	192	1.1	26.2	211
28	2734.6	16.7	18	49	234	1.0	27.2	234
29	2735.6	17.8	20	51	277	1.0	28.2	277
30	2736.6	18.0	18	50	252	1.6	29.8	403
						Total		6,752

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company	Home-Stake Production Company	Lease	Keighley Unit	Well No.	CT-1

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company			Home-Stake Production Company			Lease		Keighley Unit			Well No.		CT-1	
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	2702.8	15.4	6	72	0	0	6	88	72	0	Imp.	50+		
2	2703.6	15.6	20	242	0	0	20	66	242	0	Imp.	50+		
3	2704.6	15.6	19	230	0	0	19	73	230	6	0.197	40		
4	2706.6	17.7	17	234	0	0	17	68	234	8	0.305	40		
5	2707.6	16.2	10	126	0	0	10	78	126	3	0.100	50		
6	2708.6	15.9	16	197	0	0	16	71	197	19	0.483	35		
7	2709.6	15.9	19	234	0	0	19	67	234	3	0.104	45		
8	2714.0	16.1	5	62	0	0	5	82	62	4	0.102	45		
9	2715.7	18.3	17	242	0	0	17	65	242	13	0.500	40		
10	2716.5	18.1	23	323	3	42	20	67	281	56	1.16	15		
11	2717.6	18.0	22	307	4	56	18	66	251	20	0.529	35		
12	2718.6	16.9	24	314	2	26	22	68	288	143	3.56	15		
13	2719.6	18.7	21	305	2	29	19	70	276	93	2.02	25		
14	2720.6	15.6	25	303	0	0	25	62	303	31	0.730	25		
15	2721.6	16.4	26	331	0	0	26	66	331	55	1.17	25		
16	2722.6	17.5	20	271	2	27	18	71	244	127	6.38	15		
17	2723.6	14.3	12	133	0	0	12	78	133	6	0.211	40		
18	2724.6	15.5	14	168	0	0	14	73	168	76	1.85	15		
19	2725.6	16.1	22	275	0	0	22	70	275	48	1.23	25		
20	2726.6	14.5	19	214	0	0	19	71	214	131	7.40	15		
21	2727.6	16.2	25	314	4	50	21	68	264	147	4.13	15		
22	2728.6	15.4	22	263	1	12	21	63	251	12	0.448	40		
23	2729.6	16.7	25	324	4	52	21	71	272	19	0.569	35		
24	2730.5	17.5	23	312	2	27	21	65	285	29	0.958	40		
25	2731.6	15.9	10	123	0	0	10	75	123	10	0.254	35		

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			Home-Stake Production Company			Lease		Keighley Unit			Well No.		CT-1	
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	2732.6	15.5	17	204	0	0	17	65	204	8	0.350	40		
27	2733.6	14.8	18	207	0	0	18	71	207	48	1.08	15		
28	2734.6	16.4	18	229	1	13	17	74	216	114	2.95	15		
29	2735.6	17.5	20	271	2	27	18	67	244	60	1.29	15		
30	2736.6	18.6	18	259	1	14	17	75	245	123	5.90	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	Home-Stake Production Company	Lease	Keighley Unit	Well No.
				CT-1
Depth Interval, Feet	2716.1 - 2730.6	2734.1 - 2737.7	2716.1 - 2737.7	
Feet of Core Analyzed	8.5	3.6	12.1	
Average Percent Porosity	17.3	17.7	17.4	
Average Percent Original Oil Saturation	22.5	18.6	21.3	
Average Percent Oil Recovery	2.8	1.3	2.3	
Average Percent Residual Oil Saturation	19.7	17.3	19.0	
Average Percent Residual Water Saturation	67.8	72.4	69.3	
Average Percent Total Residual Fluid Saturation	87.5	89.7	88.3	
Average Original Oil Content, Bbls./A. Ft.	300.	254.	286.	
Average Oil Recovery, Bbls./A. Ft.	37.	17.	31.	
Average Residual Oil Content, Bbls./A. Ft.	263.	237.	255.	
Total Original Oil Content, Bbls./Acre	2,553.	914.	3,467.	
Total Oil Recovery, Bbls./Acre	316.	62.	378.	
Total Residual Oil Content, Bbls./Acre	2,237.	852.	3,089.	
Average Effective Permeability, Millidarcys	2.15	3.80	2.82	
Average Initial Fluid Production Pressure, p.s.i.	26.2	15.0	23.3	

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