

OILFIELD RESEARCH LABORATORIES

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February 26, 1959

National Associated Petroleum Company
502 ~~Rich~~ Building
Tulsa 3, Oklahoma

Attn: Mr. E. D. Lambeth

Gentlemen:

Enclosed herewith is the report of the analysis of the 1 $\frac{1}{2}$ " Rotary core taken from the Lidikay Lease, Well No. F-9, Franklin County, Kansas, and submitted to our laboratory by Mr. J. R. Marsh on February 15 and 19, 1959.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES


Carl L. McElrea

CLM:cs

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Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Co.

Company National Associated Petroleum Lease Lidikay Well No. F-9

Location SE $\frac{1}{4}$

Section 4 Twp. 16S Rge. 21E County Franklin State Kansas

Name of Sand	Squirrel
Top of Core	676.0
Bottom of Core	753.0
Pay	
Top of Sand	677.0
Pay	
Bottom of Sand	699.0
Total Feet of Permeable Sand	54.5
Good	
Total Feet of Floodable Sand	16.0

Distribution of Permeable Sand:
Permeability Range
Millidarcys

	Feet	Cum. Ft.
0 - 5	11.0	11.0
5 - 10	7.5	18.5
10 - 20	11.0	29.5
20 - 30	10.0	39.5
30 - 40	6.0	45.5
40 & above	9.0	54.5

Average Permeability Millidarcys	23.1
Average Percent Porosity	19.9
Average Percent Oil Saturation	37.2
Average Percent Water Saturation	44.2
Average Oil Content, Bbls./A. Ft.	582.
Total Oil Content, Bbls./Acre	41,311.
Average Percent Oil Recovery by Laboratory Flooding Tests	14.9
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	244.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	5,382.
Total Calculated Oil Recovery, Bbls./Acre	6,000.
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 the client.

FORMATION CORED

The detailed log of the formation cored is as follows:

<u>Depth Interval,</u>	<u>Description</u>
<u>Feet</u>	

676.0 - 687.0	- Brown sandstone.
687.0 - 699.0	- Brown laminated shaley sandstone.
699.0 - 721.0	- Laminated sandstone and shale.
721.0 - 723.0	- Gray sandy shale.
723.0 - 732.0	- Brown slightly shaley sandstone.
732.0 - 733.0	- Brown to dark shaley slightly carbonaceous sandstone.
733.0 - 735.0	- Brown shaley sandstone.
735.0 - 737.0	- Brown to dark shaley slightly carbonaceous sandstone.
737.0 - 739.0	- Brown shaley sandstone.
739.0 - 745.0	- Brown and dark carbonaceous slightly shaley sandstone.
745.0 - 746.0	- Core not received.
746.0 - 748.0	- Dark carbonaceous sandstone.
748.0 - 749.0	- Limestone.
749.0 - 753.0	- Gray shale.

Coring was started at a depth of 676.0 feet in brown sandstone and completed at 753.0 feet in gray shale. This core shows a total of 47.0 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 27.1, 4.7 and 28.4 millidarcys respectively; the overall average being 23.1 (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has a very irregular permeability profile. The permeability of the sand varies from 0.36 to a maximum of 108 millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a good weighted average percent oil saturation, namely, 37.2. The weighted average percent oil saturation of the upper, middle and lower sections is 45.1, 34.2 and 32.7 respectively. The weighted average percent water saturation of the upper, middle and lower sections is 31.6, 56.4 and 44.2 respectively; the overall average being 44.2 (See Table III). This gives an overall weighted average total fluid saturation of 81.4 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 732, 485 and 532 barrels per acre foot respectively; the overall average being 582. The total oil content, as shown by this core, is 41,311 barrels per acre (See Table III).

LABORATORY FLOODING TESTS

Part of the sand in this core responded rather well to laboratory flooding tests, as a total recovery of 5,382 barrels of oil per acre was obtained from 22.0 feet of sand. The weighted average percent oil saturation was reduced from 45.2 to 30.3, or represents an average recovery of 14.9 percent. The weighted average effective permeability of the samples is 2.58 millidarcys, while the average initial fluid production pressure is 25.7 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 69 samples tested, 45 produced water and 22 oil. This indicates that approximately 32 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.

CONCLUSION

From a study of the enclosed data, we believe that efficient primary production methods will recover approximately 2,280 barrels of oil per acre from the area represented by this core. An additional recovery of approximately 3,720 barrels of oil per acre, or an average of 232 barrels of oil per acre foot from the 16.0 feet of good floodable pay sand analyzed, should be realized by efficient water re-pressuring. The following factors were used in calculating these recoveries:

Original formation volume factor	1.06
Present formation volume factor	1.03
True water saturation, percent	30.0
Primary oil recovery	None
Calculated present oil saturation, percent	68.0
Porosity, percent	20.5
Oil saturation at abandonment, percent	30.0
Performance factor	0.50

The analysis results show 16.0 feet of good floodable pay sand in the interval extending from a depth of 677.0 to 699.0 feet. The sand in this part of the cored section has very good oil and normal water saturations, and fairly good effective permeability.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company National Associated Petroleum Co. Lease Lidikay Well No. F-9

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	676.5	20.7	38	33	71	611	22.	1.0	1.0	611	22.00
2	677.5	18.6	41	42	83	592	35.	1.0	2.0	592	35.00
3	678.5	22.8	54	27	81	957	5.7	1.0	3.0	957	5.70
4	679.5	22.4	46	27	73	800	27.	1.0	4.0	800	27.00
5	680.5	21.5	48	26	74	801	19.	1.0	5.0	801	19.00
6	681.5	21.1	42	24	66	688	40.	1.0	6.0	688	40.00
7	682.5	19.8	47	30	77	723	28.	1.0	7.0	723	28.00
8	683.5	19.8	42	31	73	646	34.	1.0	8.0	646	34.00
9	684.5	22.9	49	24	73	870	108.	1.0	9.0	870	108.00
10	685.5	23.7	46	24	70	847	48.	1.0	10.0	847	48.00
11	686.5	21.5	47	24	71	784	34.	1.0	11.0	784	34.00
12	687.5	22.2	49	26	75	844	11.	1.0	12.0	844	11.00
13	688.5	24.9	50	31	81	966	35.	1.0	13.0	966	35.00
14	689.5	19.1	40	36	76	594	20.	1.0	14.0	594	20.00
15	690.5	18.8	47	37	84	686	12.	1.0	15.0	686	12.00
16	691.5	18.9	40	37	77	587	7.7	1.0	16.0	587	7.70
17	692.5	20.6	45	32	77	705	13.	1.0	17.0	705	13.00
18	693.5	18.9	45	31	76	660	9.0	1.0	18.0	660	9.00
19	694.5	20.1	54	31	85	843	12.	1.0	19.0	843	12.00
20	695.5	20.3	44	32	76	693	31.	1.0	20.0	693	31.00
21	696.4	22.2	48	31	79	827	7.1	0.5	20.5	414	3.55
21	696.6	18.6	33	-	-	477		0.5	21.0	239	
22	697.5	18.1	38	56	94	534		1.0	22.0	534	
23	698.5	21.7	45	37	82	758		1.0	23.0	758	
24	699.5	21.5	39	51	90	651	29.	1.0	24.0	651	29.00
25	700.5	17.0	41	56	97	541	Imp.	1.0	25.0	541	0.00

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company National Associated Petroleum Co. Lease Lidikay Well No. F-9

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.		
26	701.5	15.7	20	71	91	244	Imp.	1.0	26.0	244	0.00
27	702.5	17.9	30	60	90	417		1.0	27.0	417	
28	703.5	16.1	26	68	94	325	0.70	1.0	28.0	325	0.70
29	704.5	18.5	46	48	94	661	3.4	1.0	29.0	661	3.40
30	705.5	16.4	25	70	95	319	2.4	1.0	30.0	319	2.40
31	706.5	16.3	34	57	91	431	0.61	1.0	31.0	431	0.61
32	707.5	15.4	29	68	97	347	Imp.	1.0	32.0	347	0.00
33	708.5	20.3	35	46	81	551	9.9	1.0	33.0	551	9.90
34	709.5	18.8	39	49	88	570		1.0	34.0	570	
35	710.5	17.7	43	52	95	591	0.36	1.0	35.0	591	0.36
36	711.5	20.5	43	36	79	684	0.94	1.0	36.0	684	0.94
37	712.5	20.5	47	35	82	747		1.0	37.0	747	
38	713.5	16.4	25	65	90	318	0.71	1.0	38.0	318	0.71
39	714.5	21.4	52	30	82	864	Imp.	1.0	39.0	864	0.00
40	715.5	17.6	28	58	86	383		1.0	40.0	383	
41	716.5	16.3	24	67	91	304	3.5	1.0	41.0	304	3.50
42	717.5	20.1	37	51	88	576	Imp.	1.0	42.0	576	0.00
43	718.5	18.0	43	55	98	601		1.0	43.0	601	
44	719.5	16.3	40	55	95	506		1.0	44.0	506	
45	720.5	16.8	22	73	95	287	0.50	1.0	45.0	287	0.50
47	722.5	16.5	19	74	93	244		1.0	46.0	244	
48	723.5	23.7	38	40	78	700	70.	1.0	47.0	700	70.00
49	724.5	22.0	31	46	77	530	40.	1.0	48.0	530	40.00
50	725.5	23.6	52	35	87	952	95.	1.0	49.0	952	95.00
51	726.5	21.0	33	46	79	538	16.	1.0	50.0	538	16.00
52	727.5	19.6	39	53	92	593	28.	1.0	51.0	593	28.00
53	728.5	21.0	35	48	83	570	34.	1.0	52.0	570	34.00

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company National Associated Petroleum Co. Lease Lidikay Well No. F-9

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			Ft.	Cum. Ft.		
54	729.5	22.2	23	56	396	72.	1.0	53.0	396	72.00
55	730.5	20.4	26	46	411	20.	1.0	54.0	411	20.00
56	731.5	19.4	34	49	512	7.8	1.0	55.0	512	7.80
57	732.5	20.6	27	48	432	22.	1.0	56.0	432	22.00
58	733.5	23.1	26	50	466		1.0	57.0	466	
59	734.5	21.2	35	31	576	60.	1.0	58.0	576	60.00
60	735.5	22.8	44	43	779	17.	1.0	59.0	779	17.00
61	736.5	21.1	36	36	590	25.	1.0	60.0	590	25.00
62	737.5	23.6	23	46	421	16.	1.0	61.0	421	16.00
63	738.5	20.0	33	49	512	15.	1.0	62.0	512	15.00
64	739.5	21.7	33	40	556	21.	1.0	63.0	556	21.00
65	740.5	22.3	34	40	590	16.	1.0	64.0	590	16.00
66	741.5	22.0	23	41	393	7.1	1.0	65.0	393	7.10
67	742.5	19.2	29	42	432	19.	1.0	66.0	432	19.00
68	743.5	23.2	23	40	414	5.4	1.0	67.0	414	5.40
69	744.5	19.9	38	53	587	44.	1.0	68.0	587	44.00
70	746.5	21.2	31	48	510	0.93	1.0	69.0	510	0.93
71	747.5	19.3	44	29	660	1.4	1.0	70.0	660	1.40
72	748.5	8.3	29	50	187	Imp.	1.0	71.0	187	0.00
Total								- - - -	41,311	

Oilfield Research Laboratories
SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III -B

Company	National Associated Petroleum Co.		Lease	Ludlow		Well No.	F-9
	Depth Interval, Feet	Feet of Core Analyzed		Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.		
	676.0 - 696.5	20.5		27.1	554.95		
	699.0 - 721.0	11.0		4.7	52.02		
	723.0 - 748.0	23.0		28.4	652.63		
	676.0 - 748.0	54.5		23.1	1,259.60		
	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
	676.0 - 699.0	23.0	20.8	45.1	31.6	732	16,842
	699.0 - 723.0	23.0	17.9	34.2	56.4	485	11,162
	723.0 - 749.0	25.0	20.9	32.7	44.2	532	13,307
	676.0 - 749.0	71.0	19.9	37.2	44.2	582	41,311

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RESULTS OF LABORATORY FLOODING

TABLE IV

Sample No.	Depth, Feet	National Associated Petroleum Co.		Lease		Liquor		Well No.		F-9	
		Original Oil Saturation		Oil Recovery		Residual		Volume of Water Recovered		Effective Permeability	
		%	Bbls./A. Ft.	%	Bbls./A. Ft.	% Oil	% Water	cc*	Millidarcys**	Lbs./Sq./In.	Initial Fluid Production Pressure
1	676.5	38	605	11	175	27	63	9	0.195	25	
2	677.5	41	600	14	204	27	63	22	0.570	25	
3	678.5	54	957	23	408	31	65	45	1.05	20	
4	679.5	46	808	15	264	31	64	140	5.31	20	
5	680.5	48	786	16	262	32	58	53	1.42	25	
6	681.5	42	675	14	225	28	65	84	2.63	25	
7	682.5	47	726	18	278	29	68	92	2.28	20	
8	683.5	42	655	15	234	27	67	44	1.22	20	
9	684.5	49	860	19	334	30	59	125	7.16	20	
10	685.5	46	831	16	289	30	67	84	5.68	15	
11	686.5	47	782	23	383	24	64	101	4.32	20	
12	687.5	49	849	22	381	27	60	110	7.08	15	
13	688.5	50	962	17	327	33	60	175	15.22	15	
14	689.5	40	581	3	44	37	54	6	0.144	35	
15	690.5	47	686	10	146	37	53	10	0.185	50	
16	691.5	40	603	11	166	29	63	17	0.325	25	
17	692.5	45	710	17	268	28	65	22	0.548	30	
18	693.5	45	675	14	210	31	64	7	0.192	35	
19	694.5	54	859	22	350	32	53	12	0.220	30	
20	695.5	44	693	16	252	28	59	16	0.253	35	
21	696.5	33	477	0	0	33	56	0	Imp.	50+	
22	697.5	37	531	0	0	37	53	0	Imp.	50+	
23	698.5	45	748	10	166	35	61	26	0.584	30	
24	699.5	37	626	0	0	37	56	7	0.130	35	
25	700.5	40	519	0	0	40	55	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

RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company			National Associated Petroleum Co.			Lease		Lidikay		Well No.		F-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.		
			%	Bbls./A. Ft.	%	Bbls./A. Ft.	% Oil	% Water				Bbls./A. Ft.	
26	701.5	15.6	23	279	0	0	23	68	279	Imp.	50+		
27	702.5	17.8	33	456	0	0	33	59	456	Imp.	50+		
28	703.5	15.7	27	329	0	0	27	70	329	Imp.	50+		
29	704.5	18.5	43	618	0	0	43	53	618	Imp.	50+		
30	705.5	16.4	28	356	0	0	28	69	356	Imp.	50+		
31	706.5	16.6	31	400	0	0	31	65	400	Imp.	50+		
32	707.5	15.5	26	313	0	0	26	68	313	Imp.	50+		
33	708.5	20.4	35	555	16	1	34	56	539	0.128	50		
34	709.5	18.6	38	549	0	0	38	60	549	Imp.	50+		
35	710.5	17.5	40	544	0	0	40	53	544	Imp.	50+		
36	711.5	20.4	44	698	0	0	44	54	698	Imp.	50+		
37	712.5	20.4	45	713	0	0	45	51	713	Imp.	50+		
38	713.5	16.4	26	331	0	0	26	69	331	Imp.	50+		
40	715.5	17.4	25	338	0	0	25	67	338	Imp.	50+		
41	716.5	15.9	23	284	0	0	23	66	284	Imp.	50+		
42	717.5	19.8	35	539	0	0	35	59	539	Imp.	50+		
43	718.5	18.3	40	568	0	0	40	53	568	Imp.	50+		
44	719.5	16.1	37	463	0	0	37	60	463	Imp.	50+		
47	722.5	16.4	17	216	0	0	17	76	216	Imp.	50+		
48	723.5	23.4	36	654	0	0	36	56	654	2.04	15		
49	724.5	22.1	30	515	0	0	30	62	515	8.22	25		
50	725.5	23.3	51	922	0	0	51	41	922	0.500	25		
51	726.5	21.3	35	578	0	0	35	51	578	3.27	25		
52	727.5	19.3	36	539	0	0	36	61	539	0.550	25		
53	728.5	20.8	33	533	0	0	33	59	533	0.715	25		
54	729.5	22.2	25	431	0	0	25	62	431	7.08	25		

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

RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

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.
			%	Bbbs./A. Ft.	%	Bbbs./A. Ft.	% Oil	% Water			
55	730.5	19.9	26	402	0	0	26	65	402	0.803	25
56	731.5	19.5	32	484	0	0	32	60	484	0.467	25
57	732.5	20.4	30	475	0	0	30	57	475	0.740	25
58	733.5	22.7	28	493	0	0	28	69	493	0.722	25
59	734.5	21.7	32	539	0	0	32	64	539	4.96	15
60	735.5	22.8	44	779	0	0	44	51	779	3.42	25
61	736.5	20.9	33	535	0	0	33	55	535	0.390	30
62	737.5	23.2	26	468	0	0	26	70	468	0.427	25
63	738.5	19.6	36	548	0	0	36	62	548	1.80	25
64	739.5	22.2	32	552	0	0	32	65	552	4.87	15
65	740.5	22.3	31	536	0	0	31	58	536	0.217	30
66	741.5	22.1	25	429	0	0	25	63	429	0.400	30
67	742.5	19.0	31	458	0	0	31	65	458	0.243	30
68	743.5	23.0	21	375	0	0	21	70	375	2.88	20
69	744.5	20.0	37	574	0	0	37	58	574	6.81	5
70	746.5	20.6	34	544	0	0	34	45	544	Imp.	50+
71	747.5	19.5	47	712	0	0	47	35	712	Imp.	50+
72	748.5	8.3	31	199	0	0	31	49	199	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.

Company National Associated Petroleum Co.

Lease Lidikay

Well No. F-9

Oilfield Research Laboratories

SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company	National Associated Petroleum Co.	Lease	Lidikay	Well No.	F-9
Depth Interval, Feet	676.0 - 709.0				
Feet of Core Analyzed	22.0				
Average Percent Porosity	20.9				
Average Percent Original Oil Saturation	45.2				
Average Percent Oil Recovery	14.9				
Average Percent Residual Oil Saturation	30.3				
Average Percent Residual Water Saturation	61.5				
Average Percent Total Residual Fluid Saturation	91.8				
Average Original Oil Content, Bbls./A. Ft.	736.				
Average Oil Recovery, Bbls./A. Ft.	244.				
Average Residual Oil Content, Bbls./A. Ft.	492.				
Total Original Oil Content, Bbls./Acre	16,206.				
Total Oil Recovery, Bbls./Acre	5,382.				
Total Residual Oil Content, Bbls./Acre	10,824.				
Average Effective Permeability, Millidarcys	2.58				
Average Initial Fluid Production Pressure, p.s.i.	25.7				

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