

# OILFIELD RESEARCH LABORATORIES

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February 19, 1959

Nicholas Sage  
111 South Meramac  
Clayton 5, Missouri

Dear Sir:

Enclosed herewith is the report of the analysis of the 3" Rotary core taken from the D. W. Hughes Lease, Well No. Sage #1, Montgomery County, Kansas, and submitted to our laboratory on February 13, 1959.

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

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Carl L. Pate

CLP:cs

5 c.

15-31-15E

# Oilfield Research Laboratories

## GENERAL INFORMATION & SUMMARY

Company Nicholas Sage Lease D. W. Hughes Well No. Sage #1

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

Section 15 Twp. 31S Rge. 15E County Montgomery State Kansas

Name of Sand	Peru
Top of Core	664.0
Bottom of Core	695.0
Pay	
Top of Sand	675.7
Pay	
Bottom of Sand	692.0
Total Feet of Permeable Sand	27.3
Total Feet of Floodable Sand	12.5

**Distribution of Permeable Sand:**  
Permeability Range  
Millidarcys

	Feet	Cum. Ft.
0 - 10	4.8	4.8
10 - 20	7.7	12.5
20 - 30	6.7	19.2
30 - 40	7.1	26.3
40 & above	1.0	27.3

Average Permeability Millidarcys	21.7
Average Percent Porosity	17.2
Average Percent Oil Saturation	21.2
Average Percent Water Saturation	49.2
Average Oil Content, Bbls./A. Ft.	281.
Total Oil Content, Bbls./Acre	8,389.
Average Percent Oil Recovery by Laboratory Flooding Tests	5.5
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	82.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	995.
Total Calculated Oil Recovery, Bbls./Acre	2,620.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

Salt water was used as a circulating fluid in the coring of the sand in this well. It is understood that this well was drilled in a semi-virgin area.

#### FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
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664.0 - 677.6	- Brownish gray fine grained micaceous sandstone.
677.6 - 677.9	- Dark laminated sandy shale.
677.9 - 686.2	- Light brown fine grained micaceous sandstone.
686.2 - 687.2	- Hard gray micaceous sandstone.
687.2 - 692.0	- Light brown fine grained micaceous sandstone.
692.0 - 692.5	- Hard brownish gray micaceous sandstone.
692.5 - 694.1	- Light brown fine grained micaceous sandstone.
694.1 - 695.0	- Shale.

Coring was started at a depth of 664.0 feet in brownish gray fine grained micaceous sandstone and completed at 695.0 feet in shale. This core shows a total of 29.8 feet of sandstone. For the most part, the pay is made up of light brown fine grained micaceous 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 16.6, 24.1 and 27.7 millidarcys respectively; the overall average being 21.7 (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 impermeable to a maximum of 52 millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a fairly low weighted average percent oil saturation, namely, 21.2. The weighted average percent oil saturation of the upper, middle and lower sections is 17.2, 23.6 and 24.0 respectively. The weighted average percent water saturation of the upper, middle and lower sections is 51.6, 47.6 and 47.8 respectively; the overall average being 49.2 (See Table III). This gives an overall weighted average total fluid saturation of 70.4 percent. This low total fluid saturation indicates considerable fluid was lost during coring which was probably oil.

The weighted average oil content of the upper, middle and lower sections is 227, 308 and 332 barrels per acre foot respectively; the overall average being 281. The total oil content, as shown by this core, is 8,389 barrels per acre (See Table III).

LABORATORY FLOODING TESTS

When taking into consideration that the sand in the core has a fairly low oil saturation, part of the sand responded very well to laboratory flooding tests, as a total recovery of 995 barrels of oil per acre was obtained from 12.1 feet of sand. The weighted average percent oil saturation was reduced from 23.7 to 18.2, or represents an average recovery of 5.5 percent. The weighted average effective permeability of the samples is 0.639 millidarcys, while the average initial fluid production pressure is 32.3 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 30 samples tested, 25 produced water and 11 oil. This indicates that approximately 37 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sand has a comparatively uniform effective permeability.

CONCLUSION

On the basis of the above data, it is evident that an efficient water-flood, within the vicinity of this well, will recover approximately 2,620 barrels of oil per acre or an average of 209 barrels per acre foot from the 12.5 feet of good floodable pay sand analyzed. In calculating this oil recovery value, the following factors and assumptions were employed:

Original formation volume factor	1.07
Present formation volume factor	1.03
Irreducible water saturation, percent	41.0
Primary oil recovery, percent	4.0
Present oil saturation, percent	52.8
Oil saturation at abandonment, percent	23.0
Percent porosity	18.7
Net feet of floodable pay sand	12.5
Performance factor (permeability distribution and sweep efficiency)	0.50

This core shows a clean sand section having a fairly low oil saturation, a rather high water saturation and a comparatively uniform effective permeability. It is apparent that the good pay sand is located in the interval extending from a depth of 675.7 to 692.0 feet.

**Oilfield Research Laboratories**  
**RESULTS OF PERMEABILITY TESTS**  
**TABLE I**

Company Nicholas Sage Lease D. W. Hughes Well No. Sage #1

Sample No.	Depth Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
1	664.4	37.	0.7	0.7	25.90
2	664.9	25.	0.5	1.2	12.50
3	665.4	33.	0.5	1.7	16.50
4	665.9	7.0	0.5	2.2	3.50
5	666.4	19.	0.5	2.7	9.50
6	666.9	22.	0.5	3.2	11.00
7	667.4	19.	0.5	3.7	9.50
8	667.9	23.	0.5	4.2	11.50
9	668.4	11.	0.5	4.7	5.50
10	668.9	31.	0.5	5.2	15.50
11	669.4	15.	0.5	5.7	7.50
12	669.9	10.	0.5	6.2	5.00
13	670.4	6.4	0.5	6.7	3.20
14	670.9	7.9	0.5	7.2	3.95
15	671.4	6.0	0.5	7.7	3.00
16	671.9	8.6	0.5	8.2	4.30
17	672.4	9.5	0.5	8.7	4.75
18	672.9	7.5	0.5	9.2	3.75
19	673.4	8.3	0.5	9.7	4.15
20	673.9	19.	0.5	10.2	9.50
21	674.4	14.	0.5	10.7	7.00
22	674.9	13.	0.5	11.2	6.50
23	675.4	22.	0.5	11.7	11.00
24	675.9	12.	0.5	12.2	6.00
25	676.4	24.	0.5	12.7	12.00
26	676.9	21.	0.5	13.2	10.50
27	677.4	31.	0.4	13.6	12.40
28	678.0	7.7	0.3	13.9	2.31
29	678.4	22.	0.5	14.4	11.00
30	678.9	42.	0.5	14.9	21.00
31	679.4	30.	0.5	15.4	15.00
32	679.9	18.	0.5	15.9	9.00
33	680.4	16.	0.5	16.4	8.00
34	680.9	30.	0.5	16.9	15.00
35	681.4	33.	0.5	17.4	16.50
36	681.9	38.	0.5	17.9	19.00
37	682.4	Imp.	0.5	18.4	0.00
38	682.9	28.	0.5	18.9	14.00
38	683.4	32.	0.5	19.4	16.00
40	683.9	15.	0.5	19.9	7.50

**Oilfield Research Laboratories**  
**RESULTS OF PERMEABILITY TESTS**

**TABLE I**

Company Nicholas Sage Lease D. W. Hughes Well No. Sage #1

Sample No.	Depth Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
41	684.4	17.	0.5	20.4	8.50
42	684.9	22.	0.5	20.9	11.00
43	685.4	Imp.	0.5	21.4	0.00
44	685.9	14.	0.5	21.9	7.00
45	686.4	Imp.	0.5	22.4	0.00
46	686.9	Imp.	0.5	22.9	0.00
47	687.4	25.	0.5	23.4	12.50
48	687.9	33.	0.5	23.9	16.50
49	688.4	37.	0.5	24.4	18.50
50	688.9	30.	0.5	24.9	15.00
51	689.4	3.3	0.5	25.4	1.65
52	689.9	35.	0.5	25.9	17.50
53	690.4	52.	0.5	26.4	26.00
54	690.9	30.	0.5	26.9	15.00
55	691.4	21.	0.5	27.4	10.50
56	691.9	26.	0.3	27.7	7.80
57	692.4	Imp.	0.5	28.2	0.00
58	692.9	18.	0.7	28.9	12.60
59	693.4	28.	0.5	29.4	14.00
60	694.0	25.	0.4	29.8	10.00

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## RESULTS OF SATURATION TESTS

TABLE II

Company Nicholas Sage Lease D. W. Hughes Well No. Sage #1

Sat. No.	Depth, Feet	Effective Porosity Percent	Percent Saturation		Total	Oil Content Bbls./A. Ft.	Feet of Core		Total Oil Content Bbls./Acre
			Oil	Water			Ft.	Cum. Ft.	
1	664.1	18.7	18	48	66	262	0.7	0.7	183
2	665.1	17.0	20	49	69	264	1.0	1.7	264
3	666.1	16.8	23	53	76	300	1.0	2.7	300
4	667.1	18.1	18	49	67	253	1.0	3.7	253
5	668.1	16.1	16	53	69	200	1.0	4.7	200
6	669.1	17.3	18	54	72	242	1.0	5.7	242
7	670.1	17.1	17	49	66	226	1.0	6.7	226
8	671.1	16.2	15	53	68	189	1.0	7.7	189
9	672.1	17.6	15	51	66	205	1.0	8.7	205
10	673.1	16.0	14	57	71	174	1.0	9.7	174
11	674.1	15.8	19	52	71	233	1.0	10.7	233
12	675.1	17.1	14	51	65	186	1.0	11.7	186
13	676.1	19.1	21	43	64	312	1.0	12.7	312
14	677.1	19.4	30	37	67	452	0.9	13.6	407
15	678.1	19.3	24	46	70	360	0.8	14.4	288
16	679.1	17.8	24	44	68	360	1.0	15.4	360
17	680.1	19.7	23	47	70	318	1.0	16.4	318
18	681.1	17.0	25	47	72	382	1.0	17.4	382
19	682.1	18.4	24	52	76	317	1.0	18.4	317
20	683.1	17.6	20	46	66	286	1.0	19.4	286
21	684.1	13.4	22	48	70	301	1.0	20.4	301
22	685.1	15.3	24	56	80	250	1.0	21.4	250
23	686.1	5.7	20	53	73	238	0.5	21.9	119
24	687.1	18.9	25	55	80	111	1.0	22.9	111
25	688.1		22	48	70	323	1.5	24.4	484

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RESULTS OF SATURATION TESTS

TABLE II

Company Nicholas Sage Lease D. W. Hughes Well No. Sage #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		Total	Ft.	
26	689.1	20.3	30	46	76	1.0	25.4	473
27	690.1	21.2	27	44	71	1.0	26.4	444
28	691.1	17.8	21	51	72	1.3	27.7	377
29	692.1	5.1	35	50	85	0.5	28.2	69
30	693.1	18.4	19	51	70	1.6	29.8	436
						Total		8,389

**Oilfield Research Laboratories**  
**SUMMARY OF PERMEABILITY & SATURATION TESTS**

TABLE III

Company	Lease	D. W. Hughes	Well No.	Sage #1		
Nicholas Sage						
Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.			
664.0 - 675.7	11.7	16.6	194.50			
675.7 - 686.2	9.2	24.1	221.71			
687.2 - 694.1	6.4	27.7	177.55			
664.0 - 694.1	27.3	21.7	593.76			
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
664.0 - 675.7	11.7	16.9	17.2	51.6	227	2,655
675.7 - 687.2	11.2	16.8	23.6	47.6	308	3,451
687.2 - 694.1	6.9	18.1	24.0	47.8	332	2,283
664.0 - 694.1	29.8	17.2	21.2	49.2	281	8,389

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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.	
			%	Bbls./A. Ft.	%	Bbls./A. Ft.	% Oil	% Water				Bbls./A. Ft.
1	664.1	18.4	16	228	0	0	16	68	7	0.310	45	
2	665.1	17.5	17	231	0	0	17	62	9	0.300	45	
3	666.1	16.7	20	259	0	0	20	63	6	0.307	45	
4	667.1	17.6	16	219	0	0	16	69	14	0.400	45	
5	668.1	16.2	14	176	0	0	14	69	24	0.706	35	
6	669.1	17.0	15	198	0	0	15	72	24	0.700	35	
7	670.1	16.6	17	219	0	0	17	63	2	0.100	50	
8	671.1	16.4	17	216	0	0	17	63	6	0.304	45	
9	672.1	17.0	14	185	0	0	14	63	0	Imp.	50+	
10	673.1	15.9	11	136	0	0	11	79	15	0.496	35	
11	674.1	15.6	17	206	0	0	17	65	10	0.305	45	
12	675.1	17.0	14	185	0	0	14	84	19	0.610	35	
13	676.1	18.7	21	305	44	3	18	70	30	0.900	35	
14	677.1	18.9	30	440	132	9	21	63	19	0.504	35	
15	678.1	19.0	24	354	133	9	15	67	14	0.420	35	
16	679.1	18.8	24	350	87	6	18	62	21	0.600	35	
17	680.1	17.5	23	313	41	3	20	61	11	0.300	45	
18	681.1	19.3	25	375	105	7	18	65	23	0.800	35	
19	682.1	16.4	22	280	0	0	22	59	0	Imp.	50+	
20	683.1	18.1	19	267	0	0	19	64	22	0.600	35	
21	684.1	17.2	19	253	0	0	19	63	13	0.508	35	
22	685.1	13.1	22	224	0	0	22	64	0	Imp.	50+	
23	686.1	15.2	17	200	0	0	17	67	3	0.200	50	
24	687.1	5.3	22	90	0	0	22	60	0	Imp.	50+	
25	688.1	18.7	22	320	44	3	19	65	26	0.682	30	

Company Nicholas Sage Lease D. W. Hughes Well No. Sage #1

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

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	689.1	19.9	30	463	11	170	19	70	293	30	0.695	25
27	690.1	20.8	27	435	10	161	17	64	274	29	0.671	25
28	691.1	18.3	21	298	4	57	17	63	241	35	0.900	25
29	692.1	5.6	32	139	0	0	32	54	139	0	Imp.	50+
30	693.1	17.9	19	264	1	14	18	64	250	20	0.500	30

Company Nicholas Sage Lease D. W. Hughes Well No. Sage #1

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	Nicholas Sage	Lease	D. W. Hughes	Well No.	Sage #1
Depth Interval, Feet	675.7 - 681.7	687.2 - 694.1	675.7 - 694.1		
Feet of Core Analyzed	5.7	6.4	12.1		
Average Percent Porosity	18.7	19.0	18.8		
Average Percent Original Oil Saturation	24.4	23.1	23.7		
Average Percent Oil Recovery	6.0	5.1	5.5		
Average Percent Residual Oil Saturation	18.4	18.0	18.2		
Average Percent Residual Water Saturation	64.5	65.0	64.8		
Average Percent Total Residual Fluid Saturation	82.9	83.0	83.0		
Average Original Oil Content, Bbls./A. Ft.	355.	342.	347.		
Average Oil Recovery, Bbls./A. Ft.	88.	77.	82.		
Average Residual Oil Content, Bbls./A. Ft.	267.	265.	265.		
Total Original Oil Content, Bbls./Acre	2,022.	2,188.	4,210.		
Total Oil Recovery, Bbls./Acre	502.	493.	995.		
Total Residual Oil Content, Bbls./Acre	1,520.	1,695.	3,215.		
Average Effective Permeability, Millidarcys	0.595	0.681	0.639		
Average Initial Fluid Production Pressure, p.s.i.	36.7	27.0	32.3		

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