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Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company Jackson Brothers Lease Hull Well No. 3

Location 400' FNL & 1,000' FWL

Section 35 Twp. 25S Rge. 8E County Greenwood State Kansas

Name of Band - - - - - Bartlesville

Top of Core - - - - - 2449.0

Bottom of Core - - - - - 2470.0

Top of <sup>Good</sup> Sand - - - - - 2451.7

Bottom of <sup>Good</sup> Sand - - - - - 2466.8

Total Feet of Permeable Sand (Analyzed) - - - - - 11.1

Total Feet of Floodable <sup>Pay</sup> Sand - - - - - 5.4

Distribution of Permeable Sand:  
Permeability Range  
Millidarcys

Feet

Cum. Ft.

0 - 5	3.4	3.4
5 - 10	1.1	4.5
10 - 20	3.3	7.8
20 & above	3.3	11.1

Average Permeability Millidarcys - - - - - 15.9

Average Percent Porosity - - - - - 18.7

Average Percent Oil Saturation - - - - - 16.3

Average Percent Water Saturation - - - - - 57.3

Average Oil Content, Bbls./A. Ft. - - - - - 234.

Total Oil Content, Bbls./Acre - - - - - 2,530.

Average Percent Oil Recovery by Laboratory Flooding Tests - - - - - 4.7

Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft. - - - - - 74.

Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre - - - - - 287.

Total Calculated Oil Recovery, Bbls./Acre (Primary & Waterflood) - - - - - 1,512.

Packer Setting, Feet - - - - -

Viscosity, Centipoises @ - - - - -

A. P. I. Gravity, degrees @ 60 °F - - - - -

Elevation, Feet - - - - -

A fresh water mud was used as a circulating fluid in the coring of the sand in this well. This well was drilled in a virgin area. The core was sampled by a representative of Oilfield Research Laboratories.

FORMATION CORED

The detailed log of the formation cored is as follows:

<u>Depth Interval,</u> <u>Feet</u>	<u>Description</u>
2449.0 - 2449.5	Gray sandy shale.
2449.5 - 2450.4	Gray laminated shaly sandstone.
2450.4 - 2451.7	Grayish brown carbonaceous shaly sandstone.
2451.7 - 2454.4	Light brown slightly shaly sandstone.
2454.4 - 2456.0	Gray sandy shale.
2456.0 - 2456.3	Light brown carbonaceous shaly sandstone.
2456.3 - 2456.6	Gray sandy shale.
2456.6 - 2458.8	Grayish to light brown shaly sandstone.
2458.8 - 2460.0	Gray sandy shale.
2460.0 - 2460.2	Gray shaly sandstone.
2460.2 - 2460.5	Gray sandy shale.
2460.5 - 2461.0	Grayish brown shaly sandstone.
2461.0 - 2462.7	Gray sandy shale.
2462.7 - 2462.9	Grayish brown carbonaceous shaly sandstone.
2462.9 - 2465.6	Light brown slightly shaly sandstone.
2465.6 - 2466.2	Gray sandy shale.
2466.2 - 2466.8	Light brown slightly shaly sandstone.
2466.8 - 2468.9	Gray sandy shale.
2468.9 - 2469.4	Gray shaly sandstone.

2469.4 - 2469.8 - Gray sandy shale.

2469.8 - 2470.0 - Gray shaly sandstone.

Coring was started at a depth of 2449.0 feet in gray sandy shale and completed at 2470.0 feet in gray shaly sandstone. This core shows a total of 12.2 feet of sandstone. For the most part, the pay is made up of light brown slightly shaly sandstone.

#### PERMEABILITY

For the sake of distribution, the core was divided into two sections. The weighted average permeability of the upper and lower sections is 19.2 and 12.5 millidarcys respectively; the overall average being 15.9 (See Table III). By observing the data given on the core-graph, it is noticeable that the sand has a very irregular permeability profile. The permeability of the sand varies from 0.23 to a maximum of 49 millidarcys.

#### PERCENT SATURATION & OIL CONTENT

The sand in this core shows a low weighted average percent oil saturation, namely, 16.3. The weighted average percent oil saturation of the upper and lower sections is 17.7 and 14.9 respectively. The weighted average percent water saturation of the upper and lower sections is 54.9 and 59.6 respectively; the overall average being 57.3 (See Table III). This gives an overall weighted average total fluid saturation of 73.6 percent. This low total fluid saturation indicates considerable fluid was lost during coring which was probably oil.

In an effort to determine whether or not any flushing of the sand occurred during coring, all of the saturation samples were analyzed for chloride content. The results of these tests are given in Tables

VI and VII. From the data given in these tables and on the coregraph, it is evident that very little flushing of the sand occurred during the cutting of the core.

The weighted average oil content of the upper and lower sections is 258 and 211 barrels per acre foot respectively; the overall average being 234. The total oil content, as shown by this core, is 2,530 barrels per acre (See Table III).

#### LABORATORY FLOODING TESTS

Inasmuch as the sand in the core had a low oil saturation, one would expect very little, if any, oil to be recovered by laboratory flooding tests.

A total recovery of 287 barrels of oil per acre was obtained from 3.9 feet of sand. The weighted average percent oil saturation was reduced from 20.0 to 15.3, or represents an average recovery of 4.7 percent. The weighted average effective permeability of the samples is 1.36 millidarcys, while the average initial fluid production pressure is 17.2 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 16 samples tested, all produced water and 5 oil. This indicates that all of the sand represented by these samples will take water.

#### CONCLUSION

On the basis of the above data, we estimate that approximately 1,512 barrels of oil per acre can be recovered from the area, represented by this core, by efficient primary and waterflood operations. The following data and assumptions were used in calculating the above oil recovery value:

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Original formation volume factor	1.30
Irreducible water saturation, percent	37.0
Primary recovery	None
Present oil saturation, percent	48.5
Average porosity, percent	19.8
Oil saturation after flooding, percent	15.3
Performance factor	0.55
Net floodable pay sand, feet	5.4

This core shows a very broken sand section having a low oil and rather high water saturation and a fairly good permeability and porosity. Chances are considerable oil was forced from the sand, in the core, by expansion of gas carried in solution by the oil.

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**RESULTS OF SATURATION & PERMEABILITY TESTS**

**TABLE 1-B**

Company Jackson Brothers Lease Hull Well No. 3

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.		
P-1	2449.8	-	-	-	-	-	0.23	0.4	0.4	-	0.09
1	2450.0	16.3	7	69	76	89	-	0.3	0.7	27	-
2	2450.5	18.8	14	66	80	204	3.5	0.7	1.4	143	2.45
3	2451.5	19.2	14	57	71	209	23.	0.7	2.1	146	16.10
4	2452.5	19.6	18	50	68	228	12.	1.3	3.4	296	15.60
5	2453.5	19.4	22	51	73	331	-	0.6	4.0	199	-
P-5	2453.7	-	-	-	-	-	0.81	0.8	4.8	-	0.65
6	2456.1	17.3	16	53	69	215	13.	0.3	5.1	65	3.90
7	2457.5	20.7	22	52	74	353	49.	1.4	6.5	494	68.60
8	2458.5	17.6	15	60	75	205	3.3	0.8	7.3	164	2.64
9	2460.6	17.7	16	66	82	219	1.9	0.5	7.8	109	0.95
10	2462.8	18.7	15	57	72	218	21.	0.2	8.0	44	4.20
11	2463.6	19.2	19	65	84	283	11.	1.1	9.1	311	12.10
12	2464.5	18.6	14	56	70	202	35.	1.0	10.1	202	35.00
13	2465.3	18.0	11	57	68	154	5.5	0.6	10.7	92	3.30
14	2466.5	18.8	16	46	62	233	11.	0.6	11.3	140	6.60
15	2469.0	16.1	13	63	76	162	6.2	0.5	11.8	81	3.10
16	2469.9	15.7	7	74	81	85	3.7	0.2	12.0	17	0.74

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### SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company Jackson Brothers Lease Hull Well No. 3

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft x Md.
2449.5 - 2458.0	5.6	19.2	107.39
2458.0 - 2470.0	5.5	12.5	68.63
2449.5 - 2470.0	11.1	15.9	176.02

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
2449.9 - 2458.0	5.3	19.4	17.7	54.9	258	1,370
2458.0 - 2470.0	5.5	18.1	14.9	59.6	211	1,160
2449.9 - 2470.0	10.8	18.7	16.3	57.3	234	2,530

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**RESULTS OF LABORATORY FLOODING TESTS**

**TABLE IV**

Company Jackson Brothers Lease Hull Well No. 3

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	2450.0	17.4	5	68	0	0	5	73	68	18	0.50	30
2	2450.5	18.0	16	223	0	0	16	76	223	22	0.56	25
3	2451.5	19.8	12	184	0	0	12	68	184	42	1.00	20
4	2452.5	19.1	14	206	0	0	14	66	206	47	0.90	20
5	2453.5	20.5	22	350	5	80	17	71	270	81	1.60	15
6	2456.1	17.9	16	222	0	0	16	78	222	24	0.50	25
7	2457.5	19.8	22	338	8	123	14	74	215	81	1.67	15
8	2458.5	18.0	18	251	0	0	18	79	251	22	0.50	25
9	2460.6	16.9	18	236	0	0	18	82	236	26	0.67	20
10	2462.8	18.1	19	267	2	28	17	83	239	74	1.60	15
11	2463.6	20.5	19	302	3	48	16	83	254	38	0.78	20
12	2464.5	19.8	14	215	0	0	14	85	215	73	1.70	20
13	2465.3	18.8	12	175	0	0	12	83	175	51	1.10	20
14	2466.5	18.1	16	225	1	14	15	82	211	60	1.40	20
15	2469.0	16.6	9	116	0	0	9	82	116	48	1.00	20
16	2469.9	16.0	9	112	0	0	9	87	112	38	0.89	20

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 WATER DIFFERENTIATION TESTS**

**TABLE VI**

Company Jackson Brothers Lease Hull Well No. 3

Sample No.	Depth, Feet	Chloride Content of Brine in Sand ppm	Percent Water Saturation		
			Connate	Drilling & Foreign	Total
1	2450.0	109,500			
2	2450.5	83,300			
3	2451.5	95,650			
4	2452.5	93,900			
5	2453.5	81,200			
6	2456.1	123,900			
7	2457.5	96,800			
8	2458.5	122,800			
9	2460.6	103,500			
10	2462.8	65,400			
11	2463.6	132,700			
12	2464.5	121,300			
13	2465.3	120,700			
14	2466.5	73,000			
15	2469.0	47,000			
16	2469.9	131,500			

Note: ppm -- parts per million

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SUMMARY OF WATER DIFFERENTIATION TESTS

TABLE VII

Company Jackson Brothers Lease Hull Well No. 3

Depth Interval, Feet	Chloride Content of Brine in Sand, ppm	Average Percent Connate Water	Average Percent Drilling & Foreign Water
2449.9 - 2458.0	94,641		
2458.0 - 2470.0	108,429		
2449.9 - 2470.0	101,166		

Note: ppm — parts per million.

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### SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company <u>Jackson Brothers</u>	Lease <u>Hull</u>	Well No. <u>3</u>
Depth Interval, Feet	2449.9 - 2470.0	
Feet of Core Analyzed	3.9	
Average Percent Porosity	19.8	
Average Percent Original Oil Saturation	20.0	
Average Percent Oil Recovery	4.7	
Average Percent Residual Oil Saturation	15.3	
Average Percent Residual Water Saturation	77.7	
Average Percent Total Residual Fluid Saturation	93.0	
Average Original Oil Content, Bbls./A. Ft.	309.	
Average Oil Recovery, Bbls./A. Ft.	74.	
Average Residual Oil Content, Bbls./A. Ft.	235.	
Total Original Oil Content, Bbls./Acre	1,204.	
Total Oil Recovery, Bbls./Acre	287.	
Total Residual Oil Content, Bbls./Acre	917.	
Average Effective Permeability, Millidarcys	1.36	
Average Initial Fluid Production Pressure, p.s.i.	17.2	

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