OILFIELD RESEARCH LABORATORIES
536 NORTH HIGHLAND - CHANUTE, KANSAS - PHONE HE1-2650

January 24, 1966

CRA, Incorporated
Box 445
Wellington, Kansas

Gentlemen:

Enclosed herewith is the report of the analysis of the Rotary core taken from the Woodward Lease, Well No. ~~19~~ 2 Bourbon County, Kansas, and submitted to our laboratory on January 17, 1966.

This core was sampled and the samples sealed in cans by a representative of Oilfield Research Laboratories.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Benjamin R. Pearman

BRP:rf

2 c. - Wellington, Kansas
2 c. - Muskogee, Oklahoma
1 c. - Independence, Kansas

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company CRA, Inc. Lease Woodward Well No. ~~19~~ 12

Location 515' SNL & 1580' EWL

Section 13 Twp. 25S Rge. 21E County Bourbon State Kansas

Name of Sand	Bartlesville
Top of Core	645.0
Bottom of Core	686.0
Top of Sand	645.9
Bottom of Sand	683.0
Total Feet of Permeable Sand	25.3
Total Feet of Floodable Sand	10.1

Distribution of Permeable Sand: Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 3	3.9	3.9
10 - 20	4.0	7.9
20 - 50	8.4	16.3
50 - 100	6.7	23.0
100 & above	2.3	25.3

Average Permeability Millidarcys	44.9
Average Percent Porosity	19.1
Average Percent Oil Saturation	29.5
Average Percent Water Saturation	48.3
Average Oil Content, Bbls./A. Ft.	425.
Total Oil Content, Bbls./Acre	11,391.
Average Percent Oil Recovery by Laboratory Flooding Tests	13.9
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	209.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	2,116.
Total Calculated Oil Recovery, Bbls./Acre - (Primary & Secondary)	2,950.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

Native mud was used as the circulating fluid while taking this core. The core was sampled and the samples sealed in cans by a representative of Oilfield Research Laboratories. The well was drilled in virgin territory.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
645.0 - 645.9	Shale.
645.9 - 650.0	Grayish light brown, slightly laminated, slightly shaly sandstone.
650.0 - 651.0	Gray sandy shale.
651.0 - 659.6	Grayish light brown, slightly shaly sandstone.
659.6 - 664.0	Gray sandy shale.
664.0 - 669.4	Light brown, laminated sandstone and shale.
669.4 - 671.0	Brown, slightly shaly sandstone.
671.0 - 674.5	Alternate layers of sandstone and shale.
674.5 - 680.0	Brown, laminated, slightly shaly sandstone.
680.0 - 680.5	Sandy shale.
680.5 - 682.0	Brown, laminated, slightly shaly sandstone.
682.0 - 683.3	Dark, carbonaceous, shaly sandstone.
683.3 - 686.0	Sandy shale.

Coring was started at a depth of 645.0 feet in shale and completed at 686.0 feet in sandy shale. For the most part, the pay is made up of brown, laminated, 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 46.4 and 41.9 millidarcys respectively; the overall average being 44.9 (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 impermeable to a maximum of 127. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a good weighted average percent oil saturation, namely, 29.5. The weighted average percent oil saturation of the upper and lower sections is 20.4 and 50.6 respectively. The weighted average percent water saturation of the upper and lower sections is 55.1 and 31.9 respectively; the overall average being 48.3 (See Table III). This gives an overall weighted average total fluid saturation of 77.8 percent.

The weighted average oil content of the upper and lower sections is 282 and 760 barrels per acre foot respectively; the overall average being 425. The total oil content, as shown by this core, is 11,391 barrels per acre of which 7,071 barrels are in the pay sand section (See Table III).

LABORATORY FLOODING TESTS

The sand in this core responded to laboratory flooding tests, as a total recovery of 2,116 barrels of oil per acre was obtained from 10.1 feet of sand. The weighted average percent oil saturation was reduced from 47.1 to 33.2, or represents an average recovery of 13.9 percent. The weighted average effective permeability of the samples is 1.36 millidarcys, while the average initial fluid production pressure is 18.3 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 27 samples tested, 22 produced water and 9 oil. This indicates that approximately 33 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 efficient primary and secondary operations in the vicinty of this well should recover approximately 2,950 barrels of oil per acre or an average of 292 barrels per acre foot from the 10.1 feet of floodable pay sand analyzed in this core. These recovery values were calculated using the following data and assumptions:

Original formation volume factor	1.06
Reservoir water saturation, percent	25.0
Average porosity, percent	19.1
Oil saturation after flooding, percent	33.2
Performance factor, percent	50.0
Net floodable pay sand, feet	10.1

This core shows a pay sand section (674.5 - 682.0) having a good oil saturation, a moderate water saturation and a wide variation in effective permeability to water.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company CRA, Inc. Lease Woodward Well No. 12 ~~19~~

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	646.1	23.1	5	51	56	90	112.	0.7	0.7	63	78.40
2	647.1	20.3	7	55	62	110	28.	1.0	1.7	110	28.00
3	648.1	19.6	10	60	70	152	11.	1.0	2.7	152	11.00
4	649.1	18.4	10	58	68	143	3.0	1.4	4.1	200	4.20
5	651.5	23.8	9	56	65	166	127.	0.6	4.7	99	76.20
6	652.1	19.9	8	62	70	123	32.	1.0	5.7	123	32.00
7	653.1	25.1	8	72	80	156	52.	1.0	6.7	156	52.00
8	654.1	19.9	22	62	84	340	46.	1.0	7.7	340	46.00
9	655.1	16.4	13	65	78	165	21.	1.0	8.7	165	21.00
10	656.1	21.9	11	64	75	187	89.	1.0	9.7	187	89.00
11	657.1	20.7	16	64	80	257	127.	1.0	10.7	257	127.00
12	658.1	19.3	16	58	74	240	15.	1.0	11.7	240	15.00
13	659.1	21.3	13	46	59	216	79.	1.0	12.7	216	79.00
14	664.1	16.0	45	34	79	559	0.24	0.5	13.2	280	0.12
15	669.1	17.2	44	46	90	588	15.	0.5	13.7	294	7.50
16	670.1	20.1	38	31	69	593	62.	1.6	15.3	948	99.20
17	671.1	14.5	51	43	94	574	Imp.	0.6	15.9	344	0.00
18	672.1	16.1	38	48	86	475	37.	1.0	16.9	475	37.00
19	673.1	13.3	28	65	93	289	0.62	1.0	17.9	289	0.62
20	674.1	12.7	41	57	98	405	Imp.	0.9	18.8	365	0.00
21	675.1	22.2	54	28	82	933	72.	1.1	19.9	1,027	79.20
22	676.1	20.4	43	28	71	680	49.	1.0	20.9	680	49.00
23	677.1	19.4	47	28	75	710	62.	1.0	21.9	710	62.00
24	678.1	19.2	53	26	79	791	44.	1.0	22.9	791	44.00
25	679.1	21.0	57	29	86	927	49.	1.4	24.3	1,299	68.60
26	681.1	14.9	48	50	98	554	20.	1.5	25.8	830	30.00
27	682.1	19.0	51	27	78	751	2.5	1.0	26.8	751	2.50
									Total ------	11,391	

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company CRA, Inc. Lease Woodward Well No. 12

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
645.9 - 674.5	17.3	46.4	803.24
674.5 - 683.0	8.0	41.9	335.30
645.9 - 683.0	25.3	44.9	1,138.54

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
645.9 - 674.5	18.8	19.1	20.4	55.1	282	5,303
674.5 - 683.0	8.0	19.3	50.6	31.9	760	6,088
645.9 - 683.0	26.8	19.1	29.5	48.3	425	11,391

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company CRA, Inc. Lease Woodward Well No. 12

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	646.1	22.7	6	106	0	0	6	89	106	312	13.00	10
2	647.1	20.6	9	144	0	0	9	79	144	216	6.80	10
3	648.1	19.1	12	178	0	0	12	76	178	42	1.00	20
4	649.1	18.0	10	140	0	0	10	75	140	26	0.600	25
5	651.5	23.8	10	184	0	0	10	86	184	256	20.00	10
6	652.1	20.4	7	111	0	0	7	90	111	342	14.48	10
7	653.1	24.9	7	135	0	0	7	86	135	341	14.00	10
8	654.1	20.3	24	377	0	0	24	70	377	246	6.80	10
9	655.1	16.8	13	169	0	0	13	68	169	27	0.600	20
10	656.1	22.4	10	174	0	0	10	79	174	231	16.85	10
11	657.1	21.0	16	260	0	0	16	80	260	336	15.10	10
12	658.1	19.0	17	250	0	0	17	78	250	88	2.10	10
13	659.1	21.0	12	195	0	0	12	80	195	297	8.22	10
14	664.1	16.4	45	572	0	0	45	33	572	0	Imp.	-
15	669.1	17.7	44	604	16	220	28	62	384	10	0.334	25
16	670.1	19.7	38	580	6	92	32	57	488	94	2.10	20
17	671.1	14.6	51	577	0	0	51	44	577	0	Imp.	-
18	672.1	16.6	38	489	8	103	30	63	386	32	0.875	20
19	673.1	13.5	29	303	0	0	29	66	303	0	Imp.	-
20	674.1	13.0	41	414	0	0	41	57	414	0	Imp.	-
21	675.1	22.5	54	941	17	296	37	59	645	123	2.50	10
22	676.1	20.6	43	686	14	224	29	67	462	90	2.00	10
23	677.1	19.9	47	725	16	246	31	64	479	79	2.00	10
24	678.1	19.1	53	784	17	251	36	62	533	32	0.780	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 LABORATORY FLOODING TESTS

TABLE IV

Company CRA, Inc. Lease Woodward Well No. ~~10~~ 12

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.			
25	679.1	20.6	57	911	23	367	34	62	544	29	0.780	20
26	681.1	15.2	48	565	11	130	37	54	435	16	0.500	30
27	682.1	18.8	52	757	0	0	52	29	757	0	Imp.	-

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

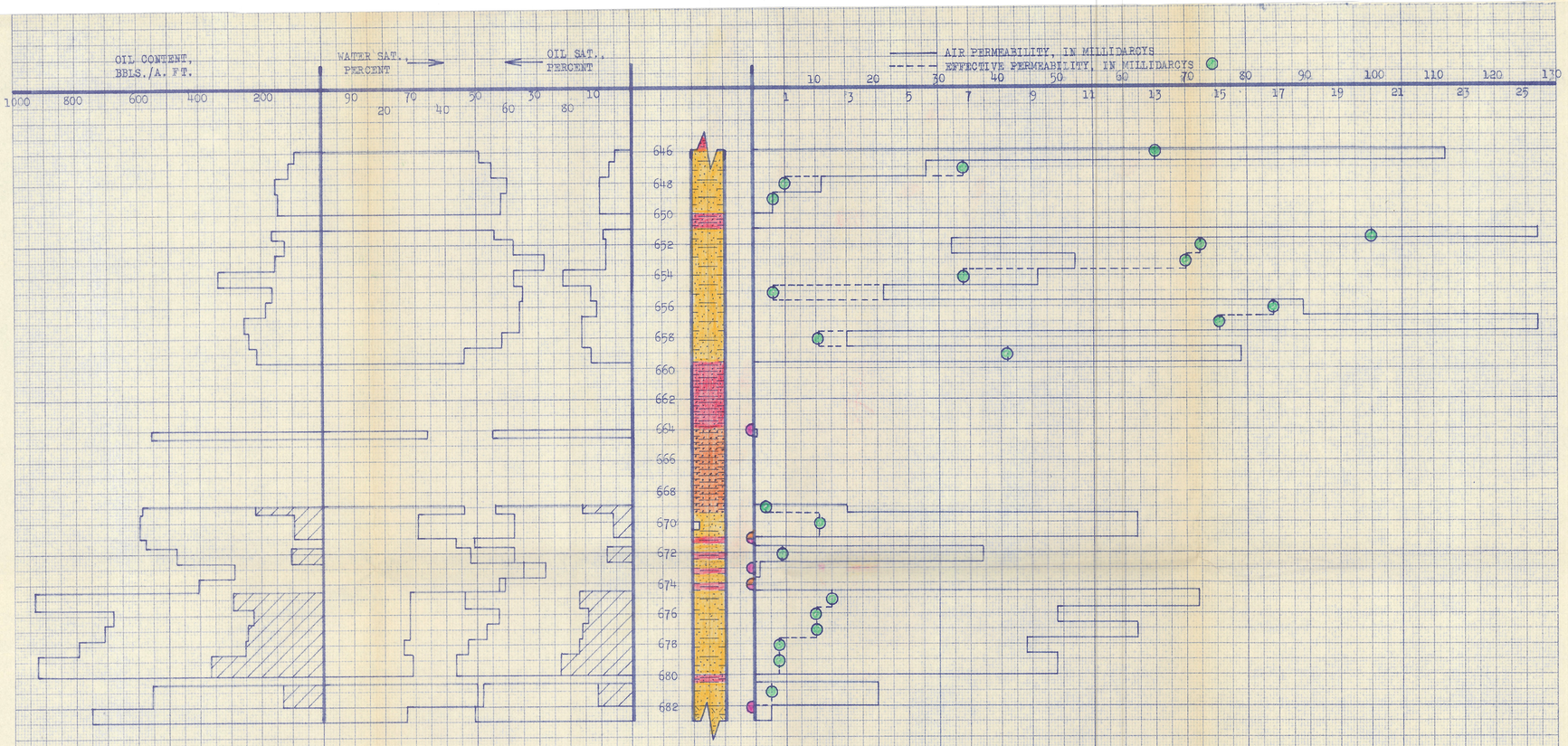
SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company CRA, Inc. Lease Woodward Well No. ~~19~~ 12

Depth Interval, Feet	645.9 - 674.5	674.5 - 683.0	645.9 - 683.0
Feet of Core Analyzed	3.1	7.0	10.1
Average Percent Porosity	18.4	19.4	19.1
Average Percent Original Oil Saturation	39.1	50.2	47.1
Average Percent Oil Recovery	8.3	16.4	13.9
Average Percent Residual Oil Saturation	30.8	34.2	33.2
Average Percent Residual Water Saturation	59.8	60.9	60.5
Average Percent Total Residual Fluid Saturation	90.6	95.1	93.7
Average Original Oil Content, Bbls./A. Ft.	553.	765.	700.
Average Oil Recovery, Bbls./A. Ft.	116.	251.	209.
Average Residual Oil Content, Bbls./A. Ft.	437.	514.	491.
Total Original Oil Content, Bbls./Acre	1,718.	5,353	7,071.
Total Oil Recovery, Bbls./Acre	360.	1,756.	2,116.
Total Residual Oil Content, Bbls./Acre	1,358.	3,597.	4,955.
Average Effective Permeability, Millidarcys	1.42	1.34	1.36
Average Initial Fluid Production Pressure, p.s.i.	21.6	16.7	18.3

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



CRA, INC.

WOODWARD LEASE WELL NO. 19
BOURBON COUNTY, KANSAS

DEPTH INTERVAL, FEET	FEET OF CORE ANALYZED	AVERAGE POROSITY, PERCENT	AVG. OIL SATURATION PERCENT	AVG. WATER SATURATION PERCENT	AVG. OIL CONTENT BBLS./A.FT.	TOTAL OIL CONTENT BBLS./ACRE	AVG. AIR PERMEABILITY, MILLIDARCYS	CALCULATED OIL RECOVERY, BBLS./ACRE
645.9 - 674.5	18.8	19.1	20.4	55.1	282	5,303	46.4	
674.5 - 683.0	8.0	19.3	50.6	31.9	760	6,088	41.9	
645.9 - 683.0	26.8	19.1	29.5	48.3	425	11,391	44.9	2,950(Primary & Secondary)

OILFIELD RESEARCH LABORATORIES
CHANUTE, KANSAS
JANUARY, 1966