OILFIELD RESEARCH LABORATORIES

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June 29, 1962

Mr. E. J. Dunigan, Jr.
Box 261
Pampa, Texas

Gentlemen:

Enclosed herewith is the report of the analysis of the Cable Tool core taken from the Frank Armstrong Lease, Well No. W-1, Crawford County, Kansas, and submitted to our laboratory on June 22, 1962.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Benjamin R. Pearman

Benjamin R. Pearman

BRP:bl

1 c - Mr. Jess Miller
1 c - Mr. Jim Guinotte
1 c - Mr. Bud Alcock

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GENERAL INFORMATION & SUMMARY

Company E.J. Dunigan, Jr. Lease Frank Armstrong Well No. W-1

Location SE NW

Section 3 Twp. 28S Rge. 23E County Crawford State Kansas

Name of Sand	Peru
Top of Core	182.0
Bottom of Core	198.3
Top of Sand	182.0
Bottom of Sand (Analyzed)	197.6
Total Feet of Permeable Sand	13.3
Total Feet of Floodable Sand (Analyzed)	5.4

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 10	0.6	0.6
10 - 20	4.2	4.8
20 - 50	8.5	13.3

Average Permeability Millidarcys	27.4
Average Percent Porosity	19.0
Average Percent Oil Saturation	35.6
Average Percent Water Saturation	55.5
Average Oil Content, Bbls./A. Ft.	540.
Total Oil Content, Bbls./Acre	7,166.
Average Percent Oil Recovery by Laboratory Flooding Tests	10.6
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	167.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	904.
Total Calculated Oil Recovery, Bbls./Acre - Primary & Secondary	1,700.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

Fresh water was used as the coring fluid while taking this core. The core was sampled and the samples sealed in cans by a laboratory representative. The well was drilled in virgin territory.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
182.0 - 188.3	Brown slightly calcareous sandstone.
188.3 - 192.8	Grayish brown laminated shaley slightly calcareous sandstone.
192.8 - 196.3	Dark laminated slightly calcareous sandstone.
196.3 - 198.3	Grayish brown calcareous sandstone.

Coring was started at a depth of 182.0 feet in sandstone and completed at 198.3 feet also in sandstone. This core shows a total of 16.3 feet of sandstone. For the most part, the pay is made up of brown slightly calcareous 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 23.7 and 30.9 millidarcys respectively; the overall average being 27.4 (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has a rather uniform permeability profile. The permeability of the sand varies from 9.9 to a maximum of 48 millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a good weighted average percent oil saturation, namely, 35.6. The weighted average percent oil saturation

of the upper and lower sections is 35.8 and 35.4 respectively. The weighted average percent water saturation of the upper and lower sections is 55.0 and 56.0 respectively; the overall average being 55.5 (See Table III). This gives an overall weighted average total fluid saturation of 91.1 percent.

The weighted average oil content of the upper and lower sections is 543 and 535 barrels per acre foot respectively; the overall average being 540. The total oil content, as shown by this core, is 7,166 barrels per acre (See Table III).

LABORATORY FLOODING TESTS

Because of the soft nature of the sand, it was impossible to obtain sufficient flood pot samples to completely analyze the entire core. However, the sand analyzed in this core responded rather well to laboratory flooding tests, as a total recovery of 904 barrels of oil per acre was obtained from 5.4 feet of sand. The weighted average percent oil saturation was reduced from 39.6 to 29.0, or represents an average recovery of 10.6 percent. The weighted average effective permeability of the samples is 1.23 millidarcys, while the average initial fluid production pressure is 28.3 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 9 samples tested, 8 produced water and 6 oil. The tests also show that the sand has a rather uniform effective permeability to water.

CONCLUSION

The laboratory data indicates that efficient primary and secondary operations in the vicinity of this well should recover approximately 600 and 1,100 barrels of oil per acre respectively. This represents a

primary recovery of 44 barrels per acre foot from 13.6 feet and a secondary recovery of 204 barrels per acre foot from the 5.4 feet of floodable pay sand analyzed. A study of the saturation data however, indicates that perhaps twice this amount of sand would respond to water-flooding.

The above recovery values were calculated using the following data and assumptions:

Original formation volume factor	1.02
(Reservoir) water saturation, percent	43.0
Primary recovery, estimated, percent	3.0
Average porosity, percent	19.9
Oil saturation after flooding, percent	29.0
Performance factor, percent	55.0
Net floodable pay sand, feet	5.4

This core shows a sand section having a good oil saturation, a moderate water saturation and a uniform effective permeability to water.

The above recovery values were calculated assuming that satisfactory injection rates will be maintained throughout the flood life of the property.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company E.J. Dunigan, Jr. **Lease** Frank Armstrong **Well No.** W-1

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	182.1	19.3	38	58	96	568	9.9	0.6	0.6	341	5.94
2	183.1	21.0	43	48	91	700	32.	1.0	1.6	700	32.00
3	184.1	18.9	44	53	97	645	20.	1.0	2.6	645	20.00
4	185.1	19.7	45	47	92	688	36.	1.0	3.6	688	36.00
5	186.1	17.8	21	59	80	290	18.	1.0	4.6	290	18.00
6	187.1	19.0	27	64	91	398	22.	1.0	5.6	398	22.00
7	188.1	20.0	33	59	92	511	22.	0.7	6.3	358	15.40
8	189.1	19.6	43	53	96	654	20.	1.0	7.3	654	20.00
9	192.1	16.3	24	72	96	304	12.	1.2	8.5	364	14.40
10	193.1	22.1	47	49	96	806	38.	0.8	9.3	645	30.40
11	194.1	19.1	29	65	94	429	35.	1.0	10.3	429	35.00
12	195.1	22.3	53	43	96	916	30.	1.0	11.3	916	30.00
13	196.1	18.2	32	57	89	451	34.	0.7	12.0	316	23.80
14	197.1	16.1	26	58	84	325	48.	1.3	13.3	422	62.40
								Total	- - - -	7,166	

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company E.J. Dunigan, Jr. Lease Frank Armstrong Well No. W-1

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
182.0 - 188.3	6.3	23.7	149.34
188.3 - 197.6	7.0	30.9	216.00
182.0 - 197.6	13.3	27.4	365.34

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
182.0 - 188.3	6.3	19.4	35.8	55.0	543	3420
188.3 - 197.6	7.0	18.8	35.4	56.0	535	3746
182.0 - 197.6	13.3	19.0	35.6	55.5	540	7166

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company Millneva Oil Company Lease Miller 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	1337.2	20.4	47	743	27	427	20	70	316	25	0.600	30
2	1338.2	17.2	34	453	13	173	21	76	280	16	0.400	30
3	1339.2	20.1	28	436	5	78	23	67	358	18	0.500	30
4	1340.2	16.2	33	414	6	75	27	70	339	47	1.25	20
5	1341.2	15.9	38	469	18	222	20	75	247	15	0.400	30
6	1342.2	17.8	24	331	5	69	19	72	262	19	0.500	30
7	1343.2	16.2	28	352	7	88	21	71	264	36	0.700	20
8	1344.2	16.0	27	335	7	87	20	69	248	27	0.600	20
9	1345.2	16.8	36	469	16	208	20	74	261	20	0.500	30
10	1346.2	17.8	27	372	8	110	19	73	262	43	0.900	20
11	1347.0	20.5	28	445	5	80	23	62	365	58	1.40	20

Note: 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 E.J. Dunigan, Jr. Lease Frank Armstrong Well No. W-1

Depth Interval, Feet	182. 0 - 188.3	188.3 - 197.6	182.0 - 197.6
Feet of Core Analyzed	3.7	1.7	5.4
Average Percent Porosity	19.7	20.3	19.9
Average Percent Original Oil Saturation	37.3	44.3	39.6
Average Percent Oil Recovery	10.7	10.3	10.6
Average Percent Residual Oil Saturation	26.6	34.0	29.0
Average Percent Residual Water Saturation	69.5	60.4	66.6
Average Percent Total Residual Fluid Saturation	96.1	94.4	95.6
Average Original Oil Content, Bbls./A. Ft.	572.	713.	617.
Average Oil Recovery, Bbls./A. Ft.	167.	169.	167.
Average Residual Oil Content, Bbls./A. Ft.	405.	544.	450.
Total Original Oil Content, Bbls./Acre	2114.	1212.	3326.
Total Oil Recovery, Bbls./Acre	617.	287.	904.
Total Residual Oil Content, Bbls./Acre	1497.	925.	2422.
Average Effective Permeability, Millidarcys	1.56	0.505	1.23
Average Initial Fluid Production Pressure, p.s.i.	27.5	30.0	28.3

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