OIL FIELD RESEARCH LABORATORIES
CHANUTE, KANSAS

August 14, 1951

32-19-22E

Hardesty & Schoonover
Richart Hotel
Garnett, Kansas

Gentlemen:

Enclosed herewith is the report of the analysis of the 2½" Rotary core taken from the S. Kehl Lease, Well No. 3, Linn County, Kansas, and submitted to our laboratory on August 10, 1951.

Very truly yours,

OIL FIELD RESEARCH LABORATORIES

Clayton A. Nattier

Clayton A. Nattier

CAN:eda

S. Kehl 3

C. HARDESTY & R. SCHOONOVER

CORE ANALYSIS REPORT

S. KEHL LEASE WELL NO. 3

LINN COUNTY, KANSAS

OIL FIELD RESEARCH LABORATORIES

CHANUTE, KANSAS

AUGUST 14, 1951

Oil Field Research Laboratories

GENERAL INFORMATION & SUMMARY

Company C. Hardesty & R. Schoonover Lease S. Kehl Well No. 3

Location 660' South of North Line and 495' West of East Line

Section 32 Twp. 19 S Rge. 22 E County Linn State Kansas

Name of Sand	Bartlesville
Top of Core	642.08
Bottom of Core	676.80
Top of Sand	647.15
Bottom of Sand	669.75
Total Feet of Permeable Sand	10.92
Total Feet of Floodable Sand	9.77

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 30	0.95	0.95
30 - 60	5.13	6.08
60 - 100	2.92	9.00
100 - 160	0.55	9.55
160 - 200	0.70	10.25
200 & above	1.32	11.57

Average Permeability, Millidarcys	89.77
Average Percent Porosity	23.03
Average Percent Oil Saturation	31.17
Average Percent Water Saturation	46.75
Average Oil Content, Bbls./A. Ft.	554.
Total Oil Content, Bbls./Acre	6,468.
Average Percent Oil Recovery by Laboratory Flooding Tests	5.26
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	93.
Aotal Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	909.
Total Calculated Oil Recovery, Bbls./Acre	3,800
Packer Setting, Feet	654.50
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	

The above averages are for that part of the sand section extending from the packer setting to the top of the cement plug.

Fresh water was used as a circulating fluid in the coring of the sand in this well.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
642.08 - 644.90	Laminated sandy shale.
644.90 - 645.50	Light brown to dark fine grained micaceous shaley sandstone.
645.50 - 647.15	Laminated sandy shale containing carbon laminations.
647.15 - 647.30	Brown fine grained laminated micaceous shaley sandstone.
647.30 - 647.90	Brown fine grained micaceous sandstone.
647.90 - 648.20	Laminated shaley sandstone.
648.20 - 650.65	Gray sandy shale.
650.65 - 650.75	Brown fine grained micaceous sandstone.
650.75 - 651.25	Gray sandy shale.
651.25 - 651.45	Brown fine grained micaceous sandstone.
651.45 - 651.60	Brown fine grained finely laminated micaceous carbonaceous sandstone.
651.60 - 653.05	Gray sandy shale.
653.05 - 653.45	Light brown fine grained laminated micaceous shaley sandstone.
653.45 - 654.30	Gray sandy shale.
654.30 - 654.50	Brown fine grained micaceous shaley sandstone.
654.50 - 654.90	Brown fine grained micaceous sandstone.
654.90 - 656.40	Gray sandy shale.
656.40 - 657.90	Brown fine grained micaceous sandstone.

657.90 - 658.10 - Finely laminated sandy shale.

658.10 - 658.90 - Brown fine grained micaceous sandstone.

658.90 - 659.30 - Brown fine grained finely laminated micaceous carbonaceous shaley sandstone.

659.30 - 660.12 - Brown fine grained slightly laminated micaceous carbonaceous sandstone.

660.12 - 661.00 - Brown fine grained micaceous sandstone.

661.00 - 661.20 - Laminated sandstone and shale.

661.20 - 661.70 - Brown fine grained micaceous sandstone.

661.70 - 662.75 - Gray shale.

662.75 - 663.10 - Light brown fine grained finely laminated micaceous carbonaceous sandstone.

663.10 - 663.93 - Brown fine grained laminated micaceous carbonaceous sandstone.

663.93 - 665.70 - Brown fine grained micaceous sandstone containing a carbon lamination.

665.70 - 666.40 - Brown fine grained laminated micaceous carbonaceous sandstone.

666.40 - 667.07 - Brown fine grained slightly laminated micaceous carbonaceous sandstone.

667.07 - 667.23 - Coal.

667.23 - 667.35 - Finely laminated shaley sandstone.

667.35 - 668.25 - Brown fine grained micaceous sandstone.

668.25 - 669.00 - Brown fine grained slightly laminated micaceous carbonaceous sandstone.

669.00 - 669.40 - Brown fine grained micaceous sandstone.

669.40 - 669.75 - Brown fine grained micaceous carbonaceous sandstone.

669.75 - 671.30 - Soft gray shale.

671.30 - 672.20 - Gray shale.

672.20 - 676.80 - According to log, dark gray to black shale (Discarded at well).

Coring was started at a depth of 642.08 feet in laminated sandy shale and completed at a depth of 676.80 feet in shale according to log. That part of the cored section extending from 672.20 to 676.80 feet was discarded at well. This core shows a total of 13.62 feet of sand of which 11.57 feet are in the pay sand section. The pay sand, for the most part, is made up of brown fine grained micaceous 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 57.44 and 102.77 millidarcys respectively; while that of the pay sand, or that part of the cored section extending from the packer setting to the top of the cement plug, is 89.77 millidarcys (See Table II). By observing the data given on the coregraph, you will note that the sand has a very irregular permeability profile.

PERCENT SATURATION & OIL CONTENT

Due to flushing during coring, the pay sand shows a fairly low weighted average percent oil saturation, namely, 31.17. The weighted average percent oil saturation of the upper and lower sections is 32.18 and 29.58 respectively. The weighted average percent water saturation of the upper and lower sections is 42.98 and 51.94 respectively; while that of the pay sand is 46.75 (See Table IV). This gives a weighted average total fluid saturation of 77.92 percent for the pay sand.

In order to get some idea of the degree of flushing that occurred during coring, each of the saturation samples was analyzed for chloride content. The results of these tests, which are given in Tables VII and VIII, indicate that flushing did occur. The flushing is more noticeable in the lower part of the sand section.

The weighted average oil content of the upper and lower sections is 542 and 538 barrels per acre foot respectively; while that of the pay sand is 554 barrels per acre foot. The total oil content, as shown by this core, is 7,034 barrels per acre of which 6,468 barrels per acre are in the pay sand section (See Table IV).

LABORATORY FLOODING TESTS

This core responded well to laboratory flooding tests in that all of the samples in the pay sand section produced oil. A total recovery of 909 barrels of oil per acre was obtained from 9.77 feet of floodable sand analyzed. The weighted average percent oil saturation was reduced from 31.04 to 25.78, or represents an average recovery of 5.26 percent. The weighted average effective permeability of the samples is 12.03 millidarcys, while the average initial fluid production pressure is 10.4 pounds per square inch (See Table VI).

By observing the data given in Table V and on the coregraph, you will note that of the 16 samples tested, 15 produced water and 13 oil. This indicates that most of the sand is floodable. The tests also show that the sand has a fairly wide variation in effective permeability.

CONCLUSION

From a study of the above data, we believe that an efficient water flood within the vicinity of this well will recover approximately 3,800 barrels of oil per acre. This is a recovery of 389 barrels of oil per acre foot from the 9.77 feet of floodable sand analyzed. In calculating the above recovery, an allowance was made for oil lost during coring. It was assumed that the true water saturation of the sand in the upper part is 35 percent and that of the lower part is 50 percent. It was also assumed that the well was drilled in virgin territory.

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SHOT RECOMMENDATION

Company C. Herdesty & R. Schoonover Lease S. Kehl Well No. 3

Depth Interval, Feet	Feet of Sand	Size of Shell Inches	Qts./Ft.	Total Quarts
659.50 - 668.50	9.0	3.5	2.0	18.0

Recommended Packer Setting 654.50 Feet

Note: Plug hole back to 669.50 Feet

Oil Field Research Laboratories

RESULTS OF PERMEABILITY TESTS

TABLE I

Company Hardesty & Schoonover Lease S. Kehl Well No. 3

Sample No.	Depth, Feet	Permeability Millidarcys	Feet of Core		Permeability Capacity Ft. x Md.
			Ft.	Cum. Ft.	
1	647.25	16.	0.15	0.15	2.40
2	647.85	2.4	0.60	0.75	1.44
3	650.70	41.	0.10	0.85	4.10
4	651.57	53.	0.15	1.00	7.95
5	653.25	25.	0.40	1.40	10.00
6	654.43	2.5	0.20	1.60	0.50
7	654.87	39.	0.40	2.00	15.60
8	656.84	46.	0.50	2.50	23.00
9	657.04	36.	0.40	2.90	14.40
10	657.45	126.	0.30	3.20	37.80
11	657.78	188.	0.30	3.50	56.40
12	658.33	34.	0.40	3.90	13.60
13	658.63	190.	0.40	4.30	76.00
14	658.97	78.	0.40	4.70	31.20
15	659.55	33.	0.82	5.52	27.06
16	660.25	30.	0.48	6.00	14.40
17	660.85	85.	0.40	6.40	34.00
18	661.23	53.	0.30	6.70	15.90
19	661.63	53.	0.20	6.90	10.60
20	662.79	2.3	0.35	7.25	0.81
21	663.37	13.	0.50	7.75	6.50
22	663.79	56.	0.33	8.08	18.48
23	664.05	392.	0.37	8.45	145.04
24	664.55	275.	0.50	8.95	137.50
25	665.00	83.	0.35	9.30	29.05
26	665.42	85.	0.35	9.65	29.75
27	666.00	38.	0.45	10.10	17.10
28	666.30	126.	0.25	10.35	31.50
29	666.90	89.	0.67	11.02	59.63
30	667.53	219.	0.45	11.47	98.55
31	668.15	30.	0.45	11.92	13.50
32	668.70	88.	0.75	12.67	66.00
33	669.30	37.	0.40	13.07	14.80
34	669.67	5.2	0.35	13.42	1.82

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SUMMARY OF PERMEABILITY TESTS

TABLE II

Company C. Hardesty & R. Schoonover Lease S. Kehl Well No. 3

Depth Interval Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity, Ft. x Md.
647.15 - 661.70	6.90	57.44	396.35
662.75 - 669.75	6.52	102.77	670.03
654.50 - 669.50	11.57	89.77	1,038.69

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RESULTS OF SATURATION TESTS

TABLE III

Company C. Hardesty & R. Schoonover Lease S. Kehl Well No. 3

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.	Cum. Ft.	
1	647.40	19.6	31.0	37.8	68.8	471	0.60	0.60	282
2	651.37	20.2	32.4	33.1	65.5	508	0.20	0.80	102
F-2	651.55	20.3	34.0	-	-	535	0.15	0.95	80
3	653.15	15.7	21.0	63.4	84.4	256	0.40	1.35	102
4	654.60	22.4	30.2	37.3	67.5	525	0.40	1.75	210
5	656.50	21.6	33.5	39.2	72.7	562	0.50	2.25	281
6	657.17	22.5	33.6	39.5	73.1	587	1.00	3.25	587
7	658.19	22.2	34.0	43.6	77.6	586	0.80	4.05	469
8	659.70	21.7	33.2	42.1	75.3	560	1.22	5.27	683
9	660.42	22.5	34.1	46.4	80.5	596	0.88	6.15	525
10	661.37	24.0	30.4	47.3	77.7	566	0.50	6.65	283
11	663.00	20.4	34.5	54.1	88.6	547	0.35	7.00	191
F-11	663.20	22.4	32.2	-	-	560	0.83	7.83	465
12	664.20	25.2	24.7	50.5	75.1	483	0.97	8.80	469
13	665.60	25.2	26.2	58.0	84.2	512	0.80	9.60	410
F-13	665.80	25.1	27.7	-	-	540	0.70	10.30	378
14	666.50	25.2	31.1	44.4	75.5	609	0.67	10.97	408
15	667.72	21.6	31.8	53.1	84.9	534	0.90	11.87	480
16	668.87	22.8	33.2	51.6	84.8	588	0.75	12.62	441
F-16	669.20	22.5	27.0	-	-	471	0.40	13.02	188
							Total	- - - -	7,034

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SUMMARY OF SATURATION TESTS

TABLE IV

Company C. Hardesty & R. Schoonover Lease S. Kehl Well No. 3

Depth Interval, Feet	Feet of Core Analyzed	Average Percent Porosity	Average Percent Oil Saturation	Average Percent Water Saturation	Average Oil Content Bbls./A. Ft.	Total Oil Content Bbls./Acre
647.30-661.70	6.65	21.58	32.18	42.98	542	3,604
662.75-669.40	6.37	23.61	29.58	51.94	538	3,430
654.50-669.50	11.67	23.03	31.17	46.75	554	6,468

Oil Field Research Laboratories

RESULTS OF LABORATORY FLOODING TESTS

TABLE V

Company O. Hardesty & R. Schoonover Lease S. Kohl 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.
			Percent	Bbls./A. Ft.	Percent	Bbls./A. Ft.	% Oil	% Water	Bbls./A. Ft.			
1	647.60	19.6	30.3	461	0.0	0	30.3	54.3	461	7	0.290	45
2	651.52	20.3	34.0	535	0.0	0	34.0	47.8	535	2	0.194	45
3	653.35	15.3	20.3	241	0.0	0	20.3	75.6	241	0	Imp.	50
4	654.73	22.2	31.9	550	7.0	121	24.9	67.3	429	190	15.11	5
5	656.70	21.8	33.9	574	7.9	134	26.0	68.2	440	153	9.08	15
6	657.33	22.8	32.5	575	6.3	111	26.2	65.9	464	165	16.87	10
7	685.45	22.5	33.8	590	8.0	140	25.8	69.5	450	106	10.63	10
8	659.95	22.3	33.6	581	8.7	150	24.9	70.6	431	181	13.10	10
9	660.67	22.8	34.0	601	6.4	113	27.6	66.8	488	209	4.87	10
10	661.52	23.7	30.5	562	6.0	111	24.5	70.8	451	196	14.22	10
11	663.20	22.4	32.2	560	4.8	84	27.4	67.9	476	180	3.11	15
12	664.35	25.1	25.1	489	2.8	55	22.3	58.3	434	179	33.65	5
13	665.80	25.1	27.7	540	2.5	49	25.2	57.4	491	144	16.30	5
14	666.70	25.2	30.6	599	1.5	29	29.1	47.0	570	134	2.40	15
15	667.95	21.6	29.0	486	2.6	44	26.4	72.1	442	167	4.13	15
16	669.20	22.5	27.0	471	2.3	40	24.7	64.0	431	178	5.60	10

Notes: cc - cubic centimeter
* Volume of water recivered at the time of maximum oil recovery.
** Determined by passing water through sample which still contains residual oil.

Oil Field Research Laboratories

SUMMARY OF LABORATORY FLOODING TESTS

TABLE VI

Company C. Hardesty & H. Schoonover Lease S. Kehl Well No. 3

Depth, Interval, Feet	654.50 - 661.70	662.75 - 669.40	654.50 - 669.40
Feet of Core Analyzed	5.30	4.47	9.77
Average Percent Porosity	22.59	23.71	23.10
Average Percent Original Oil Saturation	33.09	28.62	31.04
Average Percent Oil Recovery	7.30	2.84	5.26
Average Percent Residual Oil Saturation	25.79	25.78	25.78
Average Percent Residual Water Saturation	68.45	61.45	65.29
Average Percent Total Residual Fluid Saturation	94.24	87.32	91.07
Average Original Oil Content, Bbls./A. Ft.	580.	524.	554.
Average Oil Recovery, Bbls./A. Ft.	128.	52.	93.
Average Residual Oil Content, Bbls./A. Ft.	452.	472.	461.
Total Original Oil Content, Bbls./Acre	3,074.	2,343.	5,417.
Total Oil Recovery, Bbls./Acre	677.	232.	909.
Total Residual Oil Content, Bbls./Acre	2,397.	2,111.	4,508.
Average Effective Permeability, Millidarcys	11.95	12.11	12.03
Average Initial Fluid Production Pressure, p.s.i.	10.0	10.8	10.4

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

Oil Field Research Laboratories

RESULTS OF WATER DIFFERENTIATION TESTS

TABLE VII

Company C. Hardesty & R. Schoonover Lease S. Kehl Well No. 3

Sample No.	Depth, Feet	Chloride Content of Brine in Sand ppm	Percent Water Saturation		
			Connate	Drilling & Foreign	Total
1	647.40	19,400	35.1	2.7	37.8
2	651.37	19,700	31.2	1.9	33.1
3	653.15	16,500	50.0	13.4	63.4
4	654.60	19,100	35.0	2.3	37.3
5	656.50	17,200	32.2	7.0	39.2
6	657.17	18,900	35.7	3.8	39.5
7	658.19	17,200	35.9	7.7	43.6
8	659.70	13,300	26.8	15.3	42.1
9	660.42	16,300	36.2	10.2	46.4
10	661.37	9,250	20.9	26.4	47.3
11	663.00	13,600	35.2	18.9	54.1
12	664.20	7,860	19.0	31.5	50.5
13	665.60	13,100	36.4	21.6	58.0
14	666.50	15,700	33.3	11.1	44.4
15	667.72	18,000	45.7	7.4	53.1
16	668.87	18,300	45.2	6.4	51.6

Note: ppm - parts per million.

Oil Field Research Laboratories

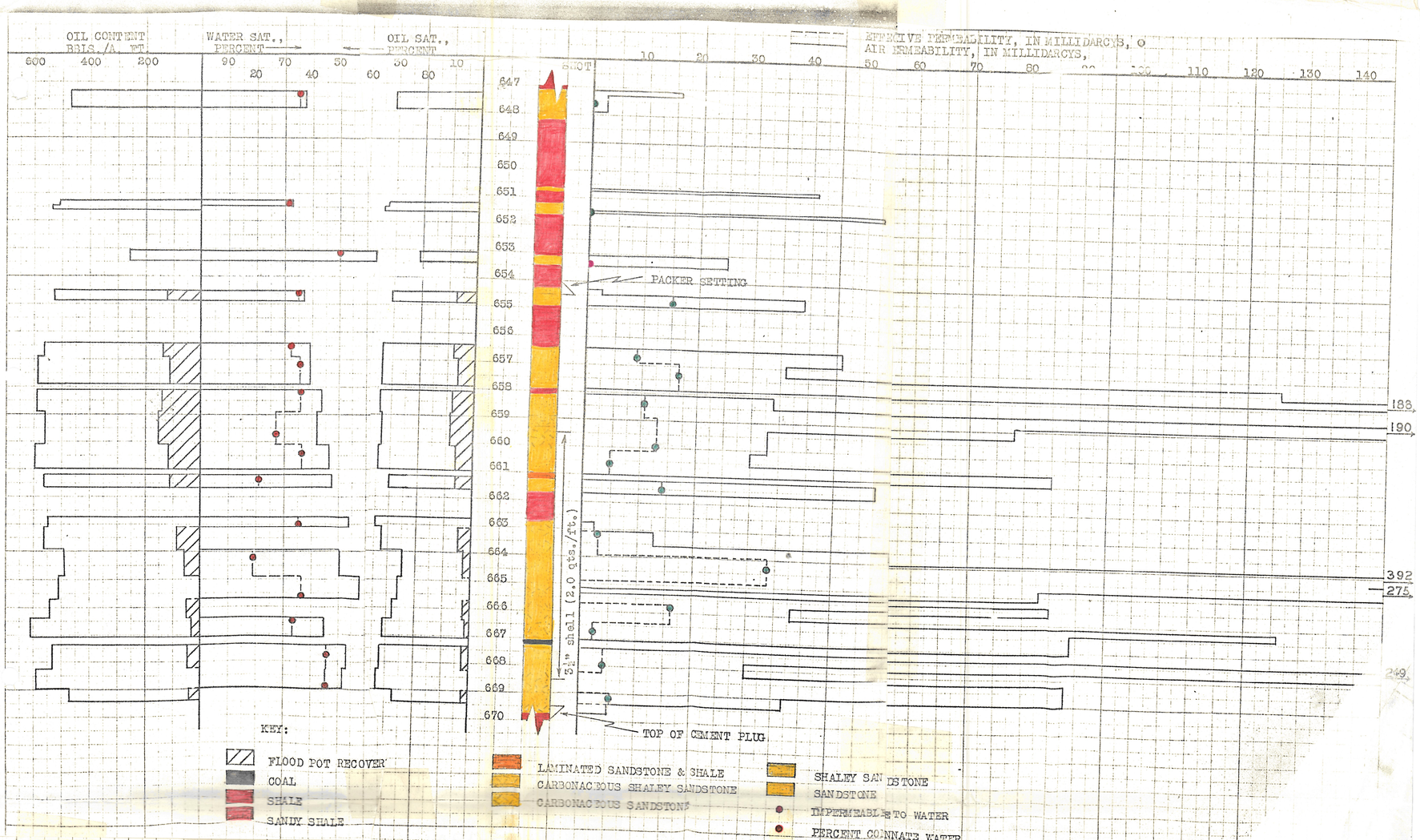
SUMMARY OF WATER DIFFERENTIATION TESTS

TABLE VIII

Company C. Hardesty & R. Schoonover Lease S. Kehl Well No. 3

Depth Interval, Feet	Chloride Content of Brine in Sand, ppm	Average Percent Connate Water	Average Percent Drilling & Foreign Water
647.30 - 661.70	16,351	33.37	9.65
662.75 - 669.40	14,250	35.38	16.51
654.50 - 669.50	15,128	38.54	13. 20

Note: ppm - parts per million.



HARDESTY & SCHOONOVER

S. KEHL LEASE — WELL NO. 3

LINN COUNTY, KANSAS

DEPTH INTERVAL FEET	FEET OF CORE ANALYZED	AVG. OIL SATURATION PERCENT	AVG. WATER SATURATION PERCENT	AVERAGE OIL CONTENT BBLS./A. FT.	TOTAL OIL CONTENT BBLS./ACRE	AVERAGE AIR PERMEABILITY, MILLIDARCYS	CALCULATED OIL RECOVERY BBLS./ACRE
647.30 - 661.70	6.65	32.18	42.98	542	3,604	57.44	
662.75 - 669.40	6.37	29.58	51.94	538	3,430	102.77	
654.50 - 669.50	11.67	31.17	46.75	554	6,468	89.77	3,800

OIL FIELD RESEARCH LABORATORIES
CHANUTE, KANSAS
AUGUST 14, 1951