STATE OF ILLINOIS
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ILLINOIS OIL SHALES

by

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ABSTRACT

Samples of Illinois shales and a limestone containing organic material were tested to determine their oil content and to evaluate their possibilities as sources of oil.

Oil content of the Pennsylvanian shale samples ranged from 0 to 40 gallons per ton, but only 3 samples contained more than 25 gallons per ton, whereas 88 percent contained less than 15 gallons. Of the shale formations for which 3 or more samples were tested, that above coal No. 2 in northern and western Illinois contained the highest average oil content, almost 16 gallons per ton.

Samples of the Mississippian and Devonian shales from southern and western Illinois all contained less than 5 gallons of oil per ton.

The Decorah limestone in Calhoun and Jo Daviess counties contains considerable organic material. A sample from Calhoun County yielded 13 gallons of oil per ton; samples from Jo Daviess County yielded less than 3 gallons per ton. Two samples of a natural residual concentrate of the organic material in the Decorah limestone in Jo Daviess County, known as oil-rock shale and found in association with zinc ore deposits, contained an average of 31 gallons per ton, but the available quantity of this shale is small.

The investigation indicates that the oil shales are more likely to be of future significance than of immediate commercial importance.

For many years attention has been directed to oil shales, especially those in Colorado, as potential sources of petroleum. The recent announcement that the Union Oil Company is erecting a retort near Rifle, Colo., for the processing of an oil shale averaging 30 gallons per ton of recoverable shale oil (Oil and Gas Jour., 1955) indicates the increasing significance of oil shales in areas affording a combination of suitable resources and favorable economic conditions.

Certain Illinois shales have been known for some time to contain oil (Worthen, 1870, p. 105; Ashley, 1917, p. 314 and 319; Winchester, 1919, p. 51; Barrett, 1922; Cox, 1914, p. 26-30). However, only a relatively few shales were tested, and the resulting data were incomplete or not comparable with current analytical data.

This investigation was undertaken to obtain up-to-date information on the oil content and other characteristics of representative shale strata exposed in various parts of Illinois. As far as can be judged from the results of this study, the oil shales of Illinois probably must be considered of potential future significance rather than of immediate commercial importance as

Fig. 1. - Locations of samples.

Table 6. - Results of Tests of Oil Rock and Oil-Rock Shale

Sample	County	Moisture (%)	Dry basis							
			Gals. of oil per ton	Specific grav. of oil (60/60)	Distillation products (percent)				Spent rock or shale*	
					Oil	Water	Spent material	Gas and loss	Ash (%)	Ignition loss (%)
NF540	JoDaviess	.2	34.9	0.920	13.4	.8	83.3	2.5	59.7	23.6
NF539	JoDaviess	.1	2.8	0.941	1.1	.5	98.1	.3	59.5	38.6
NF538	JoDaviess	.1	.2	0.920	.1	.4	99.3	.2	59.2	40.1
NF537	JoDaviess	.0	2.7	0.933	1.1	.2	98.5	.2	62.0	36.5
647	JoDaviess	.6	27.6	0.932	10.7	1.3	84.9	3.1	67.2	17.7
NF403	Calhoun	.4	12.6	0.912	4.8	1.4	93.1	.7	58.7	34.4

*Percentage based on original rock or shale.

Table 4. - Oil Content of Shale per Acre and per Square Mile

Thickness of shale (inches)	Oil content of shale (gals. per ton)	Oil content per acre (barrels)*†	Oil content per sq. mi. (barrels)
12	5	375	239,000
	10	750	479,000
	15	1125	719,000
	20	1500	959,000
24	5	750	479,000
	10	1500	959,000
	15	2245	1,438,000
	20	2995	1,917,000
36	5	1125	719,000
	10	2245	1,438,000
	15	3370	2,157,000
	20	4495	2,876,000

* Shale weight of 3900 lbs. per cu. yd. used in calculations.
† 1 barrel = 42 gals.

Table 5. - Source and Thickness of Decorah Samples

Sample	Kind of rock	Location 1/4	1/4	1/4	sec.	T.	R.	Thickness (feet)	Source
NF 540	Shale	NE	SE	SW	10	27N	1E	1 1/4	Bautsch mine
NF 539	Mostly limestone	NE	SE	SW	10	27N	1E	5	Bautsch mine
NF 538	Mostly limestone		NE	SW	34	29N	1E	15	Outcrop
NF 537	Mostly limestone		SE	SE	25	29N	1W	13	Graham-Snyder mine
647	Shale			SE	25	29N	1W	*	Graham-Snyder mine

* Hand specimen.

D-69	Peoria	-	trace	-		(less than 5 gallons per ton)				
D-70	Sangamon	2.7	11.7	0.969	4.7	4.0	88.0	3.3	67.9	20.1
D-71	Montgomery	-	3.8	-		(less than 5 gallons per ton)				
D-72	Macoupin	2.4	12.3	0.966	4.9	4.0	87.4	3.7	69.5	17.9
D-73	Macoupin	2.5	9.9	0.966	4.0	4.4	88.2	3.4	72.0	16.2
D-74	Macoupin	-	3.3†	-		(less than 5 gallons per ton)				
D-75	Greene	1.6	18.6	0.946	7.3	3.0	86.1	3.6	67.9	18.2
D-77	Macoupin	2.8	8.9	0.946	3.5	5.1	87.4	4.0	68.3	19.1
D-78	Bond	3.2	6.2	0.944	2.4	4.0	91.9	1.7	77.0	14.9
D-79	St. Clair	2.9	11.0	0.953	4.4	2.5	91.2	1.9	73.9	17.3
D-80U	Randolph	-	none	-		(less than 5 gallons per ton)				
D-80L	Randolph	-	2.6†	-		(less than 5 gallons per ton)				
D-81	Randolph	-	trace	-		(less than 5 gallons per ton)				
D-82	Randolph	2.0	15.1	0.947	6.0	2.0	90.3	1.7	69.7	20.6
D-83	Jackson	3.3	8.1	0.960	3.2	5.5	87.9	3.4	71.6	16.3
D-85	Edgar	-	trace	-		(less than 5 gallons per ton)				
D-86	Edgar	-	3.1	-		(less than 5 gallons per ton)				
D-88	Edgar	2.4	13.9	0.962	5.6	4.5	87.0	2.9	66.3	20.7
D-89	Clark	3.1	7.5	0.950	3.0	4.5	91.0	1.5	73.0	18.0
D-90	Edgar	2.1	6.9	0.945	2.7	3.4	92.5	1.4	76.7	15.8
D-91	Clark	2.4	8.3	0.965	3.4	4.1	78.1	14.4	63.3	14.8
D-92	Clark	2.0	8.8	0.968	3.5	3.0	91.1	2.4	75.0	16.1
D-93	Clark	-	1.9†	-		(less than 5 gallons per ton)				
D-94	Clark	2.7	6.9	0.971	2.8	4.0	79.1	14.1	66.8	12.3
D-95	Coles	3.4	9.4	0.961	3.8	5.0	88.9	2.3	71.1	17.8
D-96	Effingham	2.8	8.1	0.937	3.2	5.0	90.5	1.3	75.3	15.2
D-97	Clay	-	3.5	-		(less than 5 gallons per ton)				
D-98	Clinton	-	3.4	-		(less than 5 gallons per ton)				
D-99	Clinton	3.9	8.8	0.960	3.5	5.2	88.8	2.5	74.8	14.0
D-100	Menard	3.3	7.4	0.953	3.0	4.0	91.0	2.0	70.8	20.2
D-101	Cass	3.6	16.2	0.947	6.4	5.0	84.4	4.2	60.9	23.5

*Percentage based on original shale.

†Assumed specific gravity of 0.920 used because of insufficient oil produced from shale.

**In most cases, complete data were run only on samples indicating an assay of more than 5 gallons of oil per ton of shale.

Table 3. (continued)

Sample	County	Moisture in shale (%)	Dry basis: Gals. of oil per ton of shale	Specific grav. of oil (60/60)	Distillation products (percent): Oil	Water	Spent shale	Gas and loss	Spent shale*: Ash (%)	Ignition loss (%)
D-39U	Jackson	2.8	14.5	0.947	5.7	6.2	80.6	7.5	55.0	25.6
D-42	Fulton	1.6	13.1	0.937	5.1	3.5	90.9	.5	76.6	14.3
D-43	Fulton	-	trace	-	(less than 5 gallons per ton)**					
D-44	Gallatin	2.8	9.9	0.957	3.9	4.8	87.3	4.0	69.9	17.4
D-45	Henry	2.3	40.1	0.997	16.7	5.0	71.9	6.4	21.3	50.6
D-46	Bureau	-	trace	-	(less than 5 gallons per ton)					
D-47	Crawford	-	trace	-	(less than 5 gallons per ton)					
D-48	Henry	-	trace	-	(less than 5 gallons per ton)					
D-49U	Richland	3.1	4.5	0.936	1.8	6.0	79.6	12.6	66.4	13.2
D-49L	Richland	2.3	4.6	0.936	1.8	2.4	82.9	12.9	74.3	8.6
D-50	Clay	1.8	4.3	0.937	1.6	2.4	96.0	none	83.4	12.6
D-51	LaSalle	2.0	5.9	0.937	2.3	3.0	94.0	.7	78.2	15.8
D-52	LaSalle	2.0	16.7	0.997	6.9	3.0	87.1	3.0	54.9	32.2
D-53	Grundy	3.0	8.2	0.947	3.2	4.2	89.4	3.2	71.5	17.9
D-54	Grundy	2.7	8.9	0.937	3.5	4.5	89.6	2.4	71.5	18.1
D-55	LaSalle	3.1	8.5	0.936	3.3	4.5	89.5	2.7	69.8	19.7
D-56	LaSalle	2.0	25.8	0.946	10.2	3.0	82.5	4.3	54.7	27.8
D-57	Bureau	2.3	5.5	0.946	2.2	3.1	93.8	.9	81.0	12.8
D-58	LaSalle	3.6	5.6	0.946	2.2	4.0	89.5	4.3	72.8	16.7
D-59	Peoria	-	trace	-	(less than 5 gallons per ton)					
D-60	Tazewell	-	trace	-	(less than 5 gallons per ton)					
D-63	Peoria	.9	4.1	0.936	1.6	1.3	95.6	1.5	65.7	29.9
D-64	Knox	1.9	11.9	0.946	4.7	2.4	90.6	2.3	72.8	17.8
D-65	Peoria	2.8	.3	0.957	.1	2.5	96.9	.5	87.9	9.0
D-66	Fulton	-	none	-	(less than 5 gallons per ton)					
D-67	Fulton	2.0	19.1	0.969	7.7	2.2	86.8	3.3	60.9	25.9
D-68	Schuyler	2.9	17.6	0.938	6.9	4.0	85.2	3.9	59.4	25.8

D-6a	Williamson	1.8	18.0	0.944	7.1	2.6	88.8	1.5	60.7	28.1
D-6b	Williamson	.2	11.2	0.937	4.4	2.4	92.8	.4	74.2	18.6
D-7	Jackson	2.0	4.0	0.968	1.6	2.0	94.7	1.7	77.6	17.1
D-9	White	2.9	7.0	0.974	2.9	4.5	90.9	1.7	72.2	18.7
D-10	White	3.2	15.5	0.973	6.3	4.0	85.9	3.8	66.5	19.4
D-11	Montgomery	3.8	11.3	0.966	4.6	5.5	87.1	2.8	66.6	20.5
D-12	Shelby	2.6	13.8	0.968	5.6	3.8	87.1	3.5	72.9	14.2
D-14	Effingham	2.9	4.2	0.957	1.7	4.5	93.0	.8	78.9	14.1
D-15	Jefferson	-	trace	-		(less than 5 gallons per ton)				
D-16	Jefferson	.2	4.2	0.958	1.7	6.5	90.9	.9	76.1	14.8
D-17	Jefferson	-	trace	-		(less than 5 gallons per ton)				
D-19	Jefferson	3.0	36.4	0.967	14.7	6.0	75.3	4.0	31.5	43.8
D-20	Jefferson	-	trace	-		(less than 5 gallons per ton)				
D-21	Saline	2.9	9.1	0.947	3.6	3.5	91.9	1.0	74.0	17.9
D-22L	Saline	1.8	12.9	0.937	5.0	3.0	87.1	4.9	58.4	28.7
D-23	Saline	-	trace	-		(less than 5 gallons per ton)				
D-24	Saline	-	none	-		(less than 5 gallons per ton)				
D-25	Saline	1.8	3.6	0.901	1.4	2.4	94.7	1.5	78.8	15.9
D-27	Saline	2.0	8.9	0.927	3.4	4.5	90.6	1.5	66.2	24.4
D-29	Williamson	-	trace	-		(less than 5 gallons per ton)				
D-30	Williamson	2.8	6.9	0.940	2.7	4.2	92.9	.2	73.8	19.1
D-31	Saline	2.2	11.3	0.962	4.5	4.5	91.0	.0	66.8	24.2
D-32	Williamson	-	trace	-		(less than 5 gallons per ton)				
D-33	Williamson	2.2	3.7	0.932	1.4	5.7	84.4	8.5	69.1	15.3
D-34	Williamson	-	none	-		(less than 5 gallons per ton)				
D-35	Williamson	-	trace	-		(less than 5 gallons per ton)				
D-36	Johnson	5.8	11.2	0.927	4.3	9.5	78.1	8.1	48.3	29.8
D-37U	Williamson	1.9	4.7	0.927	1.8	1.9	94.3	2.0	80.6	13.7
D-37L	Williamson	1.8	11.1	0.937	4.3	2.0	91.4	2.3	72.7	18.7
D-38	Jackson	2.6	11.4	0.927	4.4	4.5	88.9	2.2	69.3	19.6

* Percentage based on original shale.

† Assumed specific gravity of 0.920 used because of insufficient oil produced from shale.

** In most cases, complete data were run only on samples indicating an assay of more than 5 gallons of oil per ton of shale.

Table 3. - Results of Tests of Shales

Sample	County	Moisture in shale (%)	Dry basis: Gals. of oil per ton of shale	Dry basis: Specific grav. of oil (60/60)	Dry basis: Distillation products (percent): Oil	Water	Spent shale	Gas and loss	Dry basis: Spent shale*: Ash (%)	Ignition loss (%)
A-9	Union	1.1	5.7	0.914	2.2	2.2	94.4	1.2	82.8	11.6
A-10	Union	0.9	6.2	0.926	2.4	1.1	95.5	1.0	81.4	14.0
A-11	Union	1.4	4.0	0.914	1.6	2.1	95.5	.8	86.2	9.3
A-12	Union	1.3	5.2	0.913	2.0	2.2	95.5	.3	84.8	10.7
A-13	Union	1.2	4.7	0.919	1.8	2.1	94.9	1.2	84.9	10.0
A-14	Union	-	3.3†	-	(less than 5 gallons per ton)**					
A-15	Union	-	trace	-	(less than 5 gallons per ton)					
A-16	Union	-	1.6†	-	(less than 5 gallons per ton)					
A-17	Union	1.4	6.4	0.936	2.5	2.5	93.8	1.2	84.9	8.9
A-18	Union	-	3.2†	-	(less than 5 gallons per ton)					
A-19	Union	1.4	4.5	0.924	1.7	2.1	95.9	.3	87.5	8.4
A-24	Pope	-	2.3†	-	(less than 5 gallons per ton)					
A-34	Calhoun	-	none	-	(less than 5 gallons per ton)					
A-44	Pike	-	2.1†	-	(less than 5 gallons per ton)					
A-45	Pike	-	2.1†	-	(less than 5 gallons per ton)					
M-2	Hardin	-	trace	-	(less than 5 gallons per ton)					
M-3	Hardin	-	none	-	(less than 5 gallons per ton)					
M-4	Hardin	-	trace	-	(less than 5 gallons per ton)					
M-5	Hardin	-	trace	-	(less than 5 gallons per ton)					
M-6	Hardin	-	1.2†	-	(less than 5 gallons per ton)					
M-7	Hardin	-	none	-	(less than 5 gallons per ton)					
M-8	Hardin	-	none	-	(less than 5 gallons per ton)					
D-1	Gallatin	-	2.9†	-	(less than 5 gallons per ton)					
D-2	Vermilion	-	3.5†	-	(less than 5 gallons per ton)					
D-3	Vermilion	3.3	9.7	0.953	3.8	4.5	90.2	1.5	70.5	19.7
D-4	Vermilion	-	trace	-	(less than 5 gallons per ton)					

Table 2. (continued)

County	Sample	Location 1/4	1/4	1/4	sec.	T.	R.	Thickness inches	Sample source
Shelby	D12	NW	NE	SW	22	10N	6E	30	Road ditch
Tazewell	D60	NE	NE	NW	18	25N	4W	5	Stream cut
Union	A14		C	NE	34	11S	2W	60	Stream cut
"	A13		C	NE	34	11S	2W	60	Stream cut
"	A12		C	NE	34	11S	2W	60	Stream cut
"	A11		C	NE	34	11S	2W	60	Stream cut
"	A9	SE	NE	NE	34	11S	2W	60	Stream cut
"	A10	SE	NE	NE	34	11S	2W	24	Cut bank
"	A15	SW	NW	SE	14	12S	2W	60	Valley wall
"	A16	SW	NW	SE	14	12S	2W	60	Valley wall
"	A17	SW	NW	SE	14	12S	2W	60	Valley wall
"	A18	SW	NW	SE	14	12S	2W	60	Valley wall
"	A19	SW	NW	SE	14	12S	2W	60	Valley wall
Vermilion	D3	SW	NW	NW	13	18N	11W	14	Stream cut
"	D4	SE	SE	SE	6	19N	11W	23	Stream cut
"	D2	NW	NW	SW	31	19N	13W	Float	Stream cut
White	D9		SW	SW	21	3S	14W	12	Stream cut
"	D10	SE	SW	SE	17	7S	10E	12	Stream cut
Williamson	D37U		NE	SW	4	9S	2E	36	Strip mine
"	D37L		NE	SW	4	9S	2E	36	Strip mine
"	D30	SE	SW	NW	10	9S	4E	41	Stream cut
"	D6a		NE	NE	28	9S	4E	9	Strip mine, bottom 9 in.
"	D6b		NE	NE	28	9S	4E	21	Strip mine, upper 21 in.
"	D33	NW	SE	NW	4	10S	4E	36	Stream cut
"	D34	NW	SW	NW	16	10S	4E	24	Valley wall
"	D32	NE	SE	NE	16	10S	4E	33	Stream cut
"	D35	SW	SW	NW	22	10S	4E	Slump	Road cut
"	D29	NW	NE	SW	30	10S	4E	18	Road cut

Table 2. (continued)

County	Sample	Location 1/4	1/4	1/4	sec.	T.	R.	Thickness inches	Sample source
Jackson	D38	SE	NW	NW	35	8S	1W	36	Mine entry
"	D39U	NE	SW	NE	36	9S	1W	30	Strip mine
Jefferson	D15	SE	SW	SE	7	1S	3E	18	Stream cut
"	D16	NW	SW	SW	22	1S	3E	15	Road cut
"	D17	NW	SW	SW	7	1S	4E	15	Road cut
"	D19	SE	SE	SE	13	3S	3E	12	Stream cut
"	D20	NE	NE	SE	35	4S	4E	40	Stream cut
Johnson	D36	SE	NE	SE	33	11S	4E	27	Stream cut
Knox	D64			S	8	9N	4E	22	Strip mine
LaSalle	D51	SE	SE	SE	9	31N	3E	24	Road cut
"	D56		SE	SW	8	32N	2E	22	Stream cut
"	D52		SW	SE	32	32N	3E	29	Stream cut
"	D58	NE	NE	NE	3	33N	1E	14	Stream cut
"	D55	SW	SE	NE	21	33N	5E	14	Stream cut
Macoupin	D77	SW	NE	NE	12	7N	7W	24	Stream cut
"	D73	SE	SE	SW	35	10N	7W	24	Stream cut
"	D72	SW	SW	SE	35	10N	7W	36	Stream cut
"	D74	NW	SW	NW	16	12N	9W	18	Stream cut
Menard	D100	C	NW	NW	36	18N	7W	12	Stream cut
Montgomery	D11	SW	SW	SE	21	7N	4W	18	Stream cut
"	D71	NE	SE	NW	28	10N	3W	26	Stream cut
Peoria	D59		C	SE	23	7N	7E	7	Road cut
"	D63		C	NE	3	8N	5E	4	Stream cut
"	D69	NE	NE	SW	11	8N	7E	14	Road cut
"	D65		NE	SW	28	9N	6E	10	Road cut
Pike	A45		NE	SW	17	6S	5W	60	Stream cut
"	A44		NE	SW	17	6S	5W	60	Stream cut
Pope	A24	NW	SW	SE	19	12S	5E	42	Railroad cut
Randolph	D81	NE	SW	NE	36	5S	5W	33	Strip mine
"	D80U	NE	SW	NE	36	5S	5W	60	Strip mine
"	D80L	NE	SW	NE	36	5S	5W	60	Strip mine
"	D82	NW	SW	NE	36	5S	5W	34	Strip mine
Richland	D49U	SW	SW	SE	15	3N	10E	36	Stream cut
"	D49L	SW	SW	SE	15	3N	10E	36	Stream cut
St. Clair	D79	SE	SE	NW	31	1N	8W	31	Strip mine
Saline	D21	NE	NE	SW	33	7S	6E	10	Stream cut
"	D31	SW	NE	SW	29	9S	5E	23	Strip mine
"	D25		NE	NW	21	10S	5E	22	Strip mine
"	D27	NW	NE	NE	30	10S	5E	35	Railroad cut
"	D24	NE	SE	NE	30	10S	6E	10	Stream cut
"	D23	NE	SE	NE	30	10S	6E	17	Stream cut
"	D22L	C	SW	NW	5	10S	7E	18	Stream cut
Sangamon	D70	NW	NE	SW	3	13N	5W	17	Stream cut
Schuyler	D68	cen.	sec.		36	2N	1W	38	Stream cut

Table 2. - Location and Thickness of Shale Samples

County	Sample	Location 1/4	1/4	1/4	sec.	T.	R.	Thickness inches	Sample source
Bond	D78	SW	NE	SE	19	6N	4W	10	Stream cut
Bureau	D46	SW	NE	NE	29	16N	6E		Strip-mine dump
"	D57	NE	SW	NW	33	16N	11E	7	Stream cut
Calhoun	A34		NW	NE	35	9S	3W	60	Weathered bluff
Cass	D101	SW	SW	NE	11	18N	11W	26	Bluff
Clark	D90	SE	SW	NW	4	9N	12W	22	Stream cut
"	D91	SE	NE	SE	3	9N	12W	31	Stream cut
"	D92	SE	NW	SE	3	9N	12W	10	Stream cut
"	D93	SW	NW	SE	3	9N	12W	32	Stream cut
"	D89	NE	NW	NW	20	11N	10W	33	Road cut
"	D94	SE	NE	SE	30	12N	12W	12	Road cut
Clay	D50	SW	SE	SW	32	3N	8E		Stream cut
"	D97	SW	SW	SW	10	4N	5E	72	Valley wall
Clinton	D99	SW	SE	SE	22	2N	5W	26	Stream cut
"	D98	NE	SW	NE	13	3N	1W	12	Stream cut
Coles	D95	SW	SW	SE	3	12N	10E	10	Stream cut
Crawford	D47	SE	SW	NW	14	5N	11W	32	Stream cut
Edgar	D88	SW	NE	SW	29	14N	10W	16	Stream cut
"	D86	SE	SE	SE	10	14N	11W	24	Stream cut
"	D85	NW	SE	NW	32	15N	10W	14	Road cut
Effingham	D96	SE	NE	NW	28	6N	6E	31	Stream cut
"	D14	SE	SE	SW	26	9N	5E	34	Stream cut
Fulton	D67		N	NE	3	3N	2E	15	Strip mine
"	D42	NE	NW	NW	17	5N	4E	24	Stream cut
"	D66	NW	SW	SW	28	6N	3E	20	Strip mine
"	D43	SW	SE	NW	14	7N	1E	15	Stream cut
Gallatin	D44	SE	NE	NW	16	9S	10E	30	Stream cut
"	D1		C	NW	16	10S	8E	36	Strip mine
Greene	D75	SW	SW	SW	24	12N	11W	30	Strip mine
Grundy	D54	NW	SE	NE	1	32N	7E	18	Stream cut
"	D53	SE	NW	NW	20	33N	7E	22	Stream cut
Hardin	M2	SW	NW	SE	25	11S	7E	60	Stream cut
"	M3	SW	NW	SE	25	11S	7E	60	Stream cut
"	M4	SW	NW	SE	25	11S	7E	60	Stream cut
"	M5	SW	NW	SE	25	11S	7E	60	Stream cut
"	M8	SW	SE	SE	30	11S	8E	48	Road cut
"	M6	SE	NE	NE	31	11S	8E	60	Road cut
"	M7	SE	NE	NE	31	11S	8E	60	Road cut
Henry	D48	SE	NW	SE	11	14N	1E		Mine dump
"	D45	NE	NE	NE	33	14N	1E		Mine dump
Jackson	D7	NW	NE	SW	22	7S	3W	30	Strip mine
"	D83	NW	SE	NE	4	7S	4W	30	Stream cut

Table 1. (continued)

Beds sampled	Geologic unit	Sample numbers
	Tradewater group	
Shale above Dekoven coal	Dekoven	D34
Shale above Davis coal	Davis	D24, D25, D32
Shale above Campbell Hill coal	Unnamed	D83
Shale below Seahorne limestone	Seahorne	D43
Shale above Stonefort limestone	Stonefort	D23, D27, D35
Shale below limestone	Seville and Curlew	D29, D45, D48
Shale above Murphysboro coal	Unnamed	D7, D39U
	Caseyville group	
Shale at position of Reynoldsburg coal	Pounds	D36
	Mississippian Chester series	
Shale	Clore formation	A24
	Kinderhook series	
Shale near top of formation	Hannibal formation	A34
	Devonian-Mississippian	
Shale, A45 above A44	Grassy Creek formation†	A44, A45
Shale, 35 ft. above creek	New Albany (Mountain Glen) formation†	A9
Shale, at base of formation	New Albany (Mountain Glen) formation†	A10
Shale, 10 to 30 ft. above base of formation; samples in ascending order	New Albany (Mountain Glen) formation†	A11-A14
Upper 25 ft. of formation; samples in descending order	New Albany (Mountain Glen) formation†	A15-A19
Shale, position in formation not known; samples in descending order	New Albany formation†	M2-M5
Shale, position in formation not known, M6 above M7	New Albany formation†	M6, M7
Shale, position in formation not known	New Albany formation†	M8

†These formations are roughly the same geologic age.

Table 1. - Sequence of Shale Beds and Geologic Units Sampled

Beds sampled	Geologic unit	Sample numbers
	Pennsylvanian ("Coal Measures")*	
	McLeansboro group	
Shales above Upper McLeansboro coals	Position uncertain	D15, D16, D20
Shale above Shumway coal	Shumway	D14, D96
Shale about 10 ft. below Trowbridge coal	Shelby	D12
Shale about 25 ft. above Omega limestone	Unnamed	D97
Shale above Upper Bogota coal	Bogota	D47, D49U, D49L, D50
Shale above Cohn coal	Cohn	D9
Shale above coal that crops out near town of Divide	Unnamed	D17, D19, D90, D94, D95
Shale below limestone	LaSalle and Livingston	D57, D86
Shale about 50 ft. above Shoal Creek limestone	Unnamed	D78
Shale about 30 ft. below Livingston limestone	Unnamed	D2, D93
Shale below Shoal Creek limestone	Shoal Creek	D10, D11, D21, D70, D72, D92, D99
Shale above Macoupin coal	Macoupin	D44, D71, D73, D77, D88, D89, D91, D98
Shale above Brouillett coal	Brouillett	D85
Shale above Exline limestone	Gimlet	D63
Shale above lower Scottville coal	Gimlet	D74
Shale above Cutler Rider II coal	Unnamed	D30
Shale above No. 7 coal	Sparland	D59, D60, D65, D69, D100
	Carbondale group	
Shale above Jamestown limestone	Jamestown	D81
Shale above Herrin limestone	Brereton	D80U, D80L
Shale above No. 6 coal	Brereton	D4, D6a, D6b, D31, D46, D51, D79, D82
Shale above No. 5 coal	St. David	D1, D37U, D37L, D53, D54, D55, D64, D66, D67
Shale above No. 4 coal	Summum	D3, D33, D38, D52
Shale above No. 2 coal	Liverpool	D22L, D42, D56, D58, D68, D75, D101

*Most of the units in the Pennsylvanian system are called cyclothems.

The thickness of the oil-rock shale varies greatly. It is best known from zinc mines and generally is thickest in the vicinity of ore deposits. Its maximum thickness in a single bed is about 3 feet. Its distribution is irregular, and the quantity available from any one mine is undetermined but probably is small in terms of large-scale oil shale production.

The Decorah oil-rock limestone crops out in Jo Daviess County at several places in sec. 34, T. 29 N., R. 1 E., and in S 1/2 sec. 3, T. 28 N., R. 1 E., south of Millbrig (Willman and Reynolds, 1947, pls. 1 and 2). However, because the outcrops are weathered, most of the samples tested were taken from fresh exposures of the oil-rock limestone and shale in zinc mines in the Galena area (table 5).

The rock strata in Jo Daviess County, although in general almost flat, are in detail considerably warped into upfolds or downfolds of small to moderate amplitude. Therefore, if Decorah limestone or dolomite were mined, the mine workings probably would not be level except in limited areas.

Results of tests on two samples of oil-rock shale and three of oil-rock limestone are given in table 6. The limestone samples contained less than 5 gallons of oil per ton. Much of this may have come from brown shale partings between the layers of the limestone. The shale samples contained between 25 and 30 gallons of oil per ton.

DECORAH LIMESTONE AND SHALE

The Decorah formation includes several rock units, one of which is a brown or gray limestone or dolomite containing organic material. Partings of brown shale containing organic material are present in varying abundance in the limestone (table 5). The organic material as seen under the microscope is a clear yellow substance, possibly a resin or wax, of algal origin (Trowbridge et al., 1916, p. 47). Outcrops are restricted to Calhoun and Jo Daviess counties.

CALHOUN COUNTY

A 7-foot outcrop of brown thin-bedded Decorah limestone with thin partings of brown shale occurs in the NE 1/4 SE 1/4 NE 1/4 sec. 6, T. 12 S., R. 2 W. Previous tests (Ruby, 1952, p. 18) of a sample from the outcrop indicated a crude-oil content of 15 to 25 gallons per ton. Another sample, NF403 (table 6), tested during the present investigation contained 12.6 gallons of oil per ton. A chemical analysis of sample NF403, as given by Lamar (1938, p. 228), follows.

SiO_2	9.80
Al_2O_3	1.83
Fe_2O_3	0.41
MgO	1.67
CaO	45.24
CO_2	36.63
Loss on ignition	41.04
Combustible carbon	3.45
$CaCO_3$	80.75
$MgCO_3$	2.16

The area wherein the Decorah limestone occurs and may be expected to crop out is a narrow north-south tract about 4 1/2 miles long and roughly one-quarter to one-half mile wide along the western side of the uplands of Calhoun County. The outcropping limestone ranges from 5 to about 10 feet thick (Ruby, 1952, p. 18). Very limited well data suggest that underground it may be thicker than this in some places. It dips to the east or northeast. The formation is overlain by the Kimmswick limestone and probably could be mined underground.

JO DAVIESS COUNTY

The Decorah limestone is encountered in the zinc mines of extreme northwestern Illinois, where it is known to the miners as the oil rock. Locally, all or most of the carbonates have been leached from the limestone by groundwater to produce a residual shale-like material known as the oil-rock shale. In previous reports this shale also is referred to in some cases as "oil rock" (Barrett, 1922). The oil-rock shale is usually brown, and some of it will burn when ignited.

The oil rock is limestone in roughly the western half of Jo Daviess County. However, east of this it is dolomite (Herbert, 1949, pls. 8 and 18). The oil-rock limestone is about 5 feet thick in the eastern part of the county, 10 feet thick in the central part, and 15 feet thick in the western portion (Herbert, 1949, pls. 8 and 18).

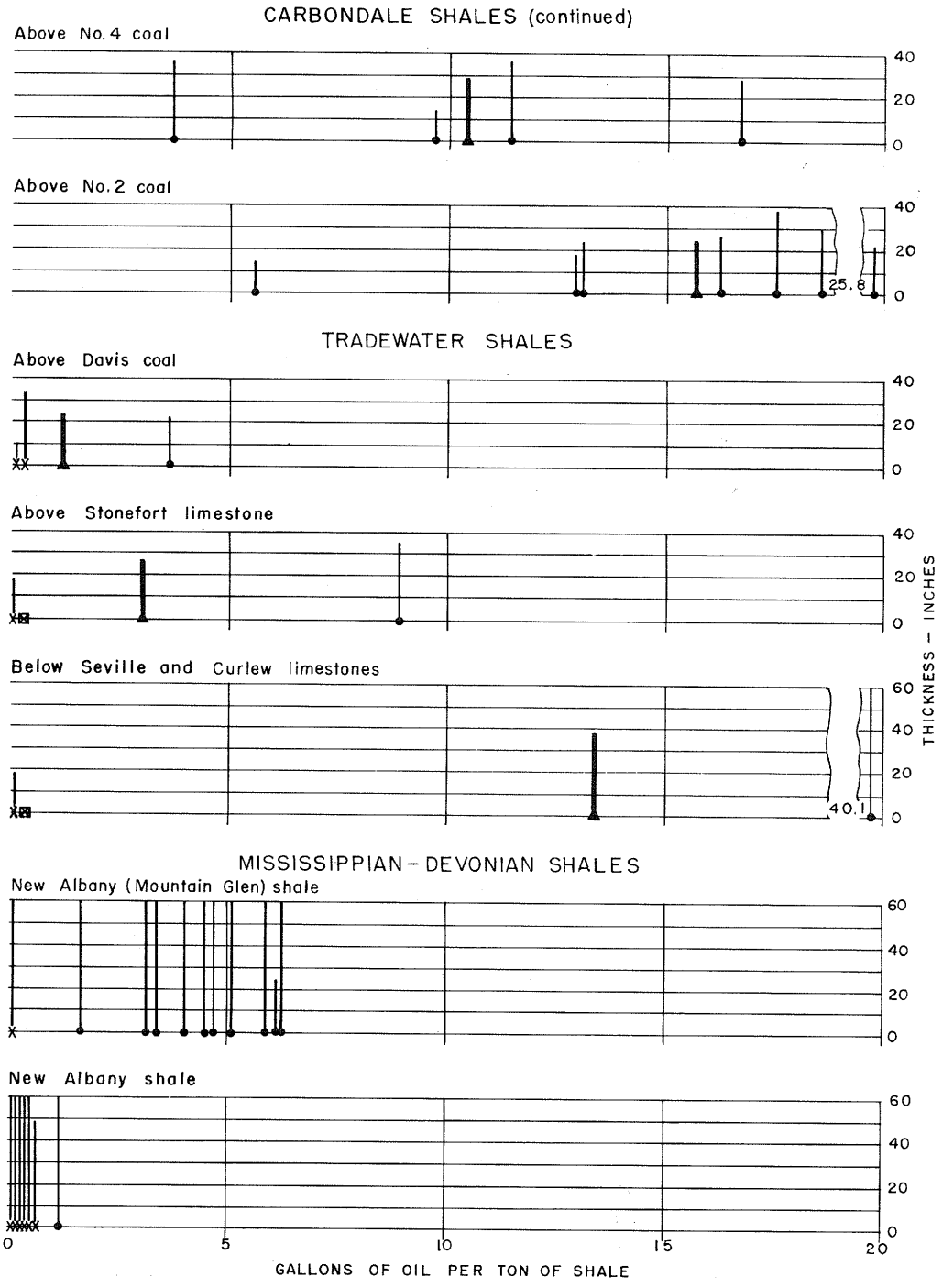
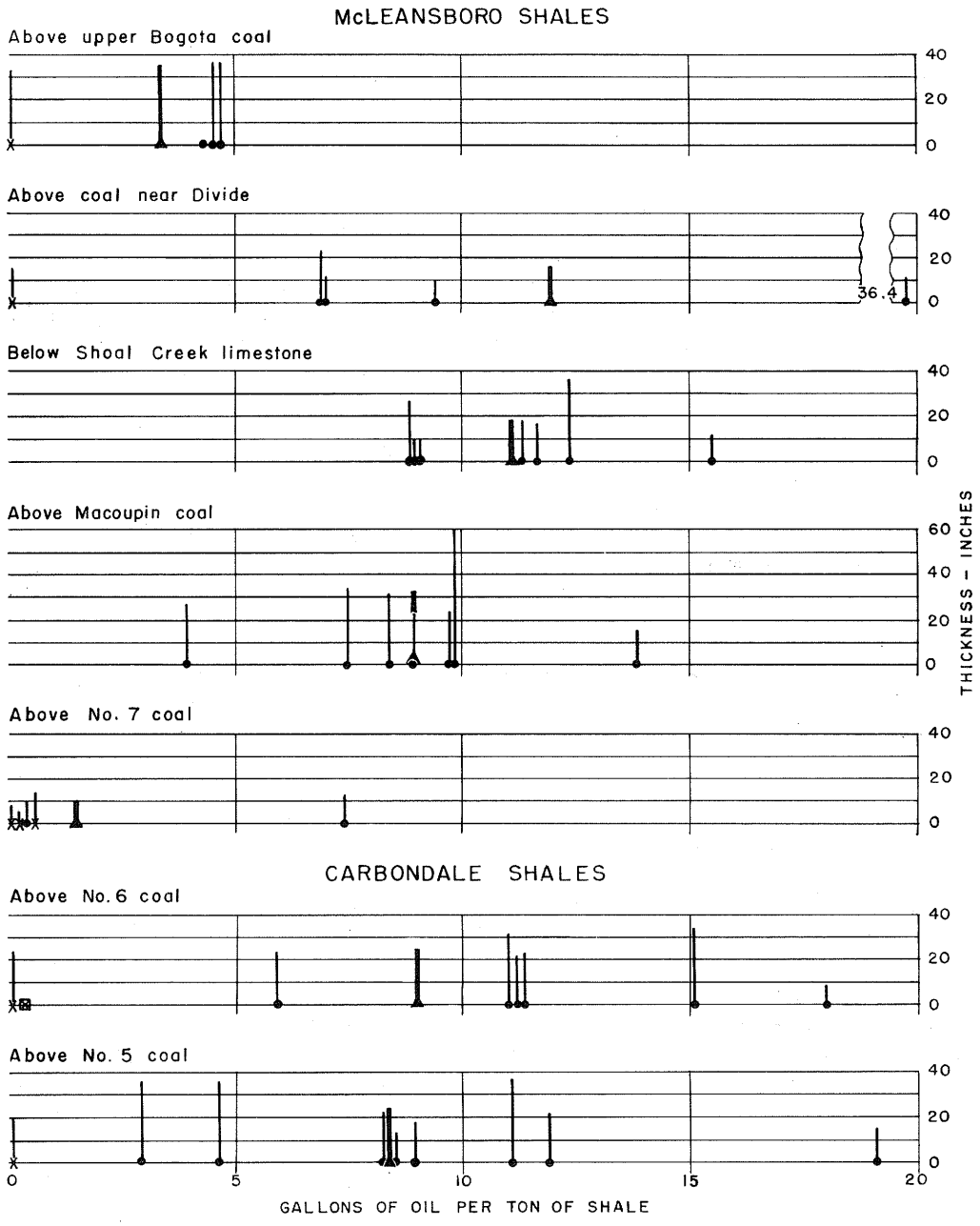


Fig. 2 (continued)



- • Sample containing more than a trace of oil
- X Sample containing a trace of oil or less
- ▲ Average oil content
- □ Sample from mine dump or float block

Fig. 2. - Thickness and oil content of shale formations from which three or more samples were tested.

Fulton, Peoria, and Knox counties in western Illinois. Presumably these shales could be recovered during coal stripping if economic conditions justified. The concomitant mining of other coals and associated shales may be similarly possible.

Mississippian and Devonian Shales

Samples from the New Albany shale in extreme southern Illinois contained less than 5 gallons of oil per ton (fig. 2). Two samples of Grassy Creek shale and a sample of Hannibal shale, both from western Illinois, yielded less than 5 gallons per ton, as did a sample of Clore shale from southern Illinois. Most of the Mississippian and Devonian shales are about 50 feet or more thick, suggesting the possibility of large tonnages of these shales.

General Results

Specific gravity of oil. - Those shale formations for which determinations of specific gravity of recovered oil were made on three or more samples are listed below, together with the average specific gravity of their oils.

Formation	Specific gravity of oil
Shale above coal near Divide	.961
Shale below Shoal Creek limestone	.958
Shale above No. 6 coal	.947
Shale above No. 5 coal	.943
Shale above No. 4 coal	.952
Shale above No. 2 coal	.942
New Albany shale	.921

Gas and loss. - The gas and loss, which is the difference between the weight lost by the sample during distillation and the weight of the oil and water recovered, was less than 3 percent for more than 60 percent of the samples that contained more than 5 gallons of oil per ton. Most of the remaining samples had a gas-and-loss figure of between 3 and 5 percent, but 4 samples ranged between 5 and 10 percent and 4 others had figures above 10 percent. Two of these latter samples, D49U and D49L, came from the same exposure in Richland County and together represent 6 feet of the shale above the Bogota coal. The other two samples are D91, representing 31 inches of the shale above the Macoupin coal in Clark County, and D94, from about 12 inches of the shale above the coal that crops out near Divide.

Ignition loss. - Ignition loss is the weight loss that results when a sample of shale from which the oil has been distilled is heated to 1000°C. Seventy-three percent of the samples containing more than 5 gallons of oil per ton had an ignition loss of less than 20 percent, 23 percent varied between 20 and 30 percent loss, and 4 percent had a loss of more than 30 percent. Of the samples showing more than 20 percent loss, two samples (D19 and D45), with ignition losses of 44 and 51 percent, respectively, had relatively high oil content, but the other samples showed no generally consistent relationship between ignition loss and oil content, suggesting the possible presence of coaly material or carbonates.

In view of the many imponderables in the present and future economic position of Illinois oil shales, it is impossible to make a realistic estimate of the quantity of commercially available oil in these shales. However, table 4 gives an idea of the amount of oil available from both an acre and a square mile of shale of different thicknesses and oil content. The data indicate that the potential shale oil resources of Illinois are indeed large.

RESULTS OF TESTS

Results of tests are given in table 3. Data regarding oil content and thickness for those shale formations from which three or more samples were taken are shown graphically in figure 2 and are discussed briefly below.

Pennsylvanian Shales

Lateral and vertical variations. - There is considerable lateral variation in oil content of the shale formations (fig. 2). For example, the shale above the coal that outcrops near Divide in northeastern Jefferson County (samples D17 and D19) shows a wide variation; one sample from the county shows only a trace of oil and another sample contains 36 gallons of oil per ton. The shale above No. 5 coal exhibits a similar, though less wide, range in oil content.

The vertical variation in oil content within some of the thicker shale formations is illustrated by samples D6A and D6B, representing the bottom 9 inches and the upper 21 inches of the shale above No. 6 coal. These contain, respectively, 18 and 11.2 gallons of oil per ton. Another pair of samples from the shale over No. 5 coal, D37U and D37L, shows about the same variation, but pairs of samples from the shale above the Bogota coal and the Herrin limestone show little variation.

Oil content. - Forty-four percent of the Pennsylvanian shales tested contain less than 5 gallons of oil per ton, 27 percent between 5 and 10 gallons, 17 percent between 10 and 15 gallons, and 12 percent more than 15 gallons. Three samples contain more than 25 gallons per ton.

Of the various black shale formations tested, the shale over No. 2 coal has the highest average oil content -- almost 16 gallons per ton. Some samples from Schuyler, Greene, and LaSalle counties contain more than 15 gallons of oil per ton, but one LaSalle County sample contains only 5.6 gallons per ton. The shale above the coal near Divide averaged 12 gallons per ton, although most of the samples contained less than 10 gallons per ton. The shale below the Shoal Creek limestone averaged 11 gallons per ton, and the shale above No. 4 coal averaged 10 gallons per ton. The shale above No. 6 coal averaged less than 10 gallons per ton, but 5 of the 8 samples contained more than 10 gallons of oil per ton.

Thickness. - Pennsylvanian shales sampled range from a few inches to 10 feet thick, but the most common range is between 18 and 36 inches.

Occurrence. - Most of the shales investigated occur above coals. Some of these coals are being mined by open-pit methods, especially No. 2 coal in LaSalle, Grundy, and Will counties in northern Illinois; No. 5 coal in Williamson, Saline, and Gallatin counties in southern Illinois and in Fulton, Peoria, and Knox counties in western Illinois; and No. 6 coal in Saline, Williamson, Randolph, Perry, Jackson, and St. Clair counties in southern Illinois and in

a source of oil. It is impossible to anticipate the effect that future economic conditions and developments in the rapidly expanding field of mineral processing may have on the recovery of oil and possible by-products from Illinois shales. However, the data in this report will provide a preliminary basis for evaluating the potential of the shales.

In addition to the shales investigated, a number of samples of Decorah limestone and of the residuum resulting from the natural leaching of the limestone, have been included in this study because of their relatively high organic content. These rocks are discussed in a separate section because they are unlike the shales in character and details of occurrence.

Most of the shale samples used in this investigation were collected by M. E. Hopkins, J. A. Simon, M. E. Ostrom, W. A. White, and J. C. Bradbury, of the Illinois State Geological Survey staff, and were the basis of a report on the uranium possibilities of Illinois shales (Ostrom et al., 1955). Tables 1 and 2 are modified from that report.

SHALE

Oil shale has been defined by Klosky (1955, p. 1) as "a sedimentary rock containing solid organic matter that yields oil upon heating to destructive distillation temperatures but is only slightly soluble in organic solvents."

SAMPLES

The 114 shale samples investigated (fig. 1) came from 41 Illinois counties, were principally of Pennsylvanian ("Coal Measures") age, and were largely the black "slaty" shales found above coals. Samples of black Devonian-Mississippian shale also were included. The location, thickness, and geologic source of the shale samples are given in tables 1 and 2. The thicknesses given for the samples in table 2 generally are the same as the entire thickness of the stratum sampled. The analytical data are shown in table 3.

METHOD OF TESTING

The oil yield and other characteristics of the Illinois shales were determined by the modified Fischer retort assay procedure as described in detail by Stanfield and Frost (1949).

The only change made in the above method was in calculating the oil yield when insufficient oil was produced for accurate measurement of specific gravity. Instead of using a specific gravity of 0.950 at 60°/60° F. as recommended in the Stanfield and Frost report, a specific gravity of 0.920 at 60°/60° F. was used. The specific gravity of 0.920 was derived from a study of duplicate runs of 30 shale samples.

AVAILABILITY AND AMOUNT

It is probable that most of the shale beds sampled occur in nearly flat-lying deposits beneath an area of a square mile or more at some, or many, places in Illinois. Under suitable economic conditions, some deposits might be worked as a source of oil shale by strip or underground mining. As some of the shales are associated with coal, the concomitant mining of shale and coal is conceivable.

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