Albert Mines, New Brunswick, at time of mining albertite vein.

CANADA

DEPARTMENT OF MINES AND RESOURCES

MINES, FORESTS AND SCIENTIFIC SERVICES BRANCH

BUREAU OF MINES

SUMMARY OF INVESTIGATIONS ON NEW BRUNSWICK OIL SHALES

CONDUCTED BY

THE FORMER MINES AND GEOLOGY BRANCH
DEPARTMENT OF MINES AND RESOURCES

Under Agreement with the Province of New Brunswick
1942

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SUMMARY AND CONCLUSIONS

The oil shales of New Brunswick have been known for many years, and in the past hundred years various unsuccessful attempts have been made by different companies to mine them for the extraction of oil.

Owing to the shortage of petroleum products in Canada, it was decided that the possibilities of the development of these oil shales should be explored. Consequently, on May 28, 1942, an agreement was entered into between the Dominion Government and the Government of the Province of New Brunswick for this purpose. The agreement provided for diamond drilling of deposits of oil shale located in Albert and Westmorland counties, the work to be undertaken by the Mines and Geology Branch[1] of the Department of Mines and Resources pursuant to the recommendation of the Oil Controller. An expenditure of $50,000 was provided for, and under the agreement the Dominion Government was to bear 75 per cent of the cost of the exploration and the Provincial Government the remaining 25 per cent. It was decided to explore the deposits in the Rosevale, Taylor Village, and Albert Mines areas, and, if any of these were found worthy of development, to study the best methods of extracting the oil from the shales with a view to the construction of a plant for the production of crude oil.

Tenders for diamond drilling were invited and a contract was awarded to the lowest tenderer, the Inspiration Mining and Development Company. Drilling started at Rosevale on May 28, 1942.

Explorations were carried out in the three most promising areas, viz:

Rosevale, Albert county, from May to August.

Taylor Village, Westmorland county, during July and August.

Albert Mines, Albert county, from July to December.

The following footages were drilled:

		Feet
Rosevale area	36 holes	10,380
Taylor Village area	7 "	1,052
Albert Mines area	36 "	13,122
	Aggregating	24,554

The lengths of holes varied from 99 feet to 1,004 feet. The three deepest holes were drilled to lengths of 788, 1,000, and 1,004 feet, and the remaining holes averaged 312 feet in length. Sixty-three holes were drilled at angles to the vertical in an endeavour to cut the beds as nearly as possible at right angles to the stratification, and the remaining holes were vertical.

[1] Mines, Forests and Scientific Services Branch, November 1, 1947

ROSEVALE AREA

At Rosevale most of the shales were found to be of much lower grade than had been anticipated. Although some bands of shale assaying 20 gallons of oil to the ton were cut in a few holes the same bands in adjacent holes showed a much lower content, so that 20-gallon shale is patchy in occurrence and limited in extent. The main bulk contains from 1 to 9 gallons of oil to the ton. The tonnage of material of good grade is much too small for cheap methods of mining and when the accompanying low-grade material is taken into consideration the over-all values are too low to be of interest even under present conditions.

TAYLOR VILLAGE AREA

The results of the drilling at Taylor Village also were disappointing, the shales in this area assaying for the most part less than 10 gallons a ton.

ALBERT MINES AREA

At Albert Mines the results obtained were more encouraging. A large tonnage, estimated at 100,000,000 tons to a depth of 400 feet, averages 10·6 gallons and of this tonnage about 2,000,000 tons average 20 gallons. However, to take out the higher grade shale by open-cut methods would involve excavating a total of 20,000,000 tons of shale and it was estimated that the average oil content of this material would be 12 to 14 gallons to the ton. It was considered that this was too low a grade to be economically important.

Owing to limited experience in Canada on the development of oil shales, advice was sought of officials of the Foreign Division of the Office of the Petroleum Administration for War, in Washington. In the Foreign Division of the Petroleum Administration for War there were several officials who had had wide experience in the development of oil shales in Scotland, Esthonia, other parts of Europe, the United States, and Australia. These officials confirmed our own conclusion that the results of our explorations did not warrant development of the New Brunswick oil shales, which conclusion was based on the following:

(*a*) For the establishment of a shale-oil industry consideration should be given only to shales that yield at least 20 gallons of oil to the ton and that are available in quantity by cheap quarrying methods.

(*b*) The best area of New Brunswick oil shales explored contains only 2,000,000 tons of 20-gallon shale associated with much low-grade material. The winning of this 20-gallon shale would not be a simple matter of quarrying, but of selective mining of the richer seams.

(*c*) Operations where there have been successful extractions of oil from shales are few in number, of small capacity, are based on shale of much higher oil-content than that found in New Brunswick, and generally are carried out with the aid of subsidies.

CONCLUSIONS

The investigations of the New Brunswick oil shales carried out by the Department of Mines and Resources have not brought to light any major addition to the available oil resources of Canada. Nevertheless, the work carried out has been of very distinct value in that it constitutes the first systematic determination of the true average oil content of the New Brunswick shales, which during the past 75 years have been given wide publicity. Most of the previous calculations concerning the oil content of these shales have been based on the assay of a comparatively few selected samples that were not representative of any appreciable tonnage. In contrast with this the conclusions reached above are based on the results of more than 3,000 assays of drill-cores taken in 5-foot sections.

W. B. TIMM,
Director, Mines, Forests and Scientific Services Branch

Ottawa, May, 1943.

SECTION I

EXPLORATION OF OIL SHALES IN THE ROSEVALE AREA[1]

(S. C. Ells)

The so-called Rosevale area lies approximately 20 miles by road to the southwest of the city of Moncton. It may also be reached from Turtle Creek railway station, distant 9 miles by road, and from the railway station at Hillsborough, distant approximately 16 miles by road. That part of the area referred to in this report extends in an east-west direction through a distance of approximately 3·4 miles, and its width varies from 800 feet to 2,400 feet. Its areal extent is approximately 2·5 square miles.

The geology of Albert county has been discussed in various reports prepared from time to time by geologists of the Dominion and Provincial Governments.[2] It may, however, be briefly stated that the oil shales constitute a part of the so-called Albert series, which consists of shales, sandstones, and conglomerates. This series extends westward from Memramcook River, between Memramcook and Dorchester, through a distance of approximately 70 miles. In places it is obscured by overlying drift and strata of younger rocks.

To the south, east, and north, the limits of that part of Rosevale area within which oil shales are exposed are well defined. The southern boundary coincides with the Precambrian rocks of the northern flank of Caledonia Mountain; to the east and north, shales disappear under younger conglomerates and sandstones; to the west, the area is arbitrarily considered as bounded by Stuart Brook, as shown on Figure 1 (in pocket), although exposures of shale continue westward beyond that stream.

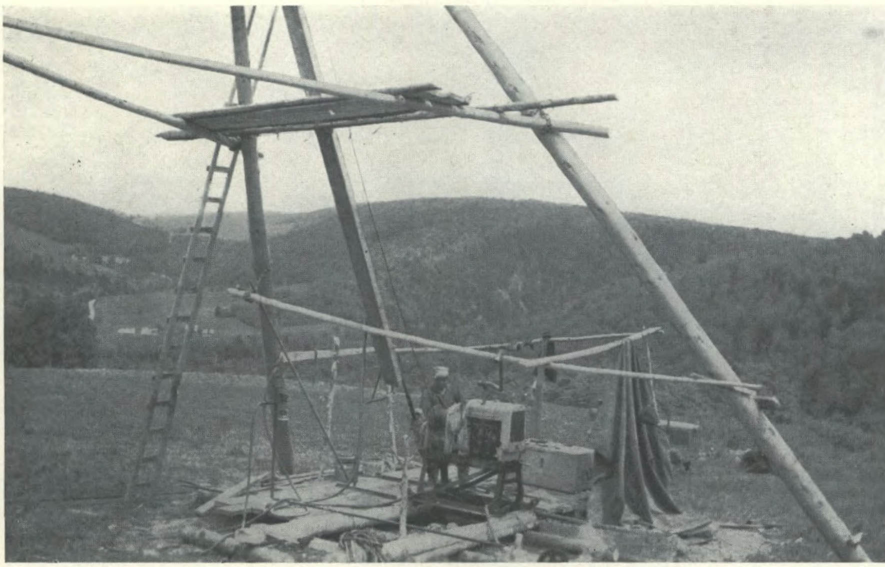
Attention was first directed to the oil shales of New Brunswick as a result of the discovery of albertite in Albert county in 1849, and the years subsequent to 1860 were marked by intermittent efforts to develop commercial production in the Rosevale area. During the period 1860-65, a small and somewhat primitive retorting unit was established and operated at Baltimore, a small settlement (on the Hillsborough road) approximately one-half mile northeast of Rosevale Post Office. Shale treated was mined from various short tunnels within a radius of two-thirds of a mile. As a result of increasing production of well petroleum in Pennsylvania and in Ontario, operations at the Baltimore plant were discontinued, apparently about 1865. During and subsequent to 1900, a number of holes were drilled

[1] The Rosevale area took its name from Rosevale Post Office which, at one time, was situated on the E. Stevens farm near the forks of the Hillsborough and Caledonia Mountain roads. With the advent of rural mail delivery the Post Office was closed in 1922.

[2] *Bituminous Shales of New Brunswick and Nova Scotia, with Notes on the Geology of Oil Shales of Scotland;* R. W. Ells; Geol. Surv., Canada, Sum. Rept. 1908.
Oil Shales of Canada, R. W. Ells, Geol. Surv., Canada, Sum. Rept. 1909.
Joint Report on the Bituminous Shales of New Brunswick and Nova Scotia; R. W. Ells, Repts. Nos. 55 and 1107; Dept. of Mines, Canada, 1909.
Oil Shales of Canada; S. C. Ells, Mines Branch, Dept. of Mines, Canada, Sum. Rept. 1921.
Geology of the Moncton Map Area; W. J. Wright, Mem. 129, Geol. Surv., Canada, 1922.
Oil Shales from Rosevale; A. A. Swinnerton, Rept. No. 689, Mines Branch, Dept. of Mines, Canada, 1928

and, in some instances, coring equipment was used; in other instances the object was to secure structural data and percussion drilling tools were used. Unfortunately, many of the core samples were lost and no authentic

PLATE II



A. Hole No. 3, Shale Hill, Rosevale, New Brunswick. Valley on soft Albert shales, Precambrian ridge on right, Moncton conglomerate ridge on left.

B. View showing contact of Albert shales and Moncton conglomerate, Rosevale, New Brunswick.

information regarding thickness and quality of shales intersected is available. During the winter of 1907-08, a shipment of approximately 50 tons of shale was mined from two short tunnels near the eastern end of the Rosevale area and subsequently passed through the experimental retort of the Pumpherston Oil Company at Pumpherston, Scotland. Results indicated an average oil content of 40 gallons of oil and 76·9 pounds of ammonium sulphate per ton of shale. During the period 1921-22 the D'Arcy Exploration Company, and in 1927-29 the Maritime Eduction Company, installed distillation equipment on the west branch of Turtle Creek, but no commercial production was attained.

Meanwhile, in the absence of adequate data, unfounded statements regarding oil shales of the Rosevale area were given wide publicity. It is true that to some extent, these statements were apparently substantiated by analyses of small shipments that had been made from time to time. Unfortunately, however, it now appears that such shipments, including that sent to the Pumpherston Oil Company, consisted of selected shale and did not accurately represent the true value of beds from which the shale was obtained. In this connection it should be noted that in 1908 Dr. R. W. Ells had emphasized the extensive sampling by means of core drilling that always preceded shale mining operations in the Scottish fields. Dr. Ells further stated "such preliminary work" (namely, core drilling) "is an absolute necessity to obtain suitable locations for plants or for a correct estimation of the economic value of the several portions of the field."[1]

Finally, in 1942, shortage of crude petroleum in Canada and in the eastern part of the United States again directed attention to the oil shales of the province of New Brunswick, and a contract to core drill a minimum of 10,000 feet in the Rosevale area was awarded to the Inspiration Mining and Development Company. On May 25 the contractor's drilling equipment reached Turtle Creek station, and by May 29, drilling of holes Nos. 1, 2, and 3 was under way. Field work was under the supervision of the Mines and Geology Branch of the Department of Mines and Resources.

The writer and A. A. Swinnerton were designated as representatives of the Mines and Geology Branch. The writer prepared detailed geological and topographical maps of the area, indicated the positions of all drilling sites, and issued necessary instructions to the drilling contractor. Mr. Swinnerton established a field laboratory, supervised the work of eight laboratory assistants, and was responsible for all analyses of core samples. Dr. W. J. Wright, Provincial Geologist, represented the Mines Department of the province of New Brunswick, maintained close touch with the progress of drilling operations, and co-operated in every possible way to ensure the success of field work. On July 7, the writer was transferred to other duties in western Canada and supervision of subsequent drilling in Albert and Westmorland counties was assigned to Dr. F. J. Alcock.

Three diamond drills were operated by the drilling contractor on a 24-hour per day basis, and during parts of May, June, and July, thirty-six wells aggregating 10,381 feet were drilled in the Rosevale area. This footage may be subdivided as follows:

			Feet	Per cent
Overburden (including uncompacted material and stratified rock)			1,005	(9·6)
Shales	8,171 feet	(78·7%)	9,376	(90·4)
Sandstones and conglomerates associated with shales	1,205 feet	(11·7%)		
Total			10,381	

[1] Geol. Surv., Canada, Dept. of Mines, Sum. Rept. 1908, p. 134.

Quality of shale beds intersected was determined by analysing eight hundred and eighteen representative samples. In addition, thirty-six samples from various outcrops and tunnels were also analysed.

An abridged summary of logs of holes drilled is given in Table 1. Positions of all holes drilled are indicated on the map of the Rosevale area (Figure 1, in pocket).

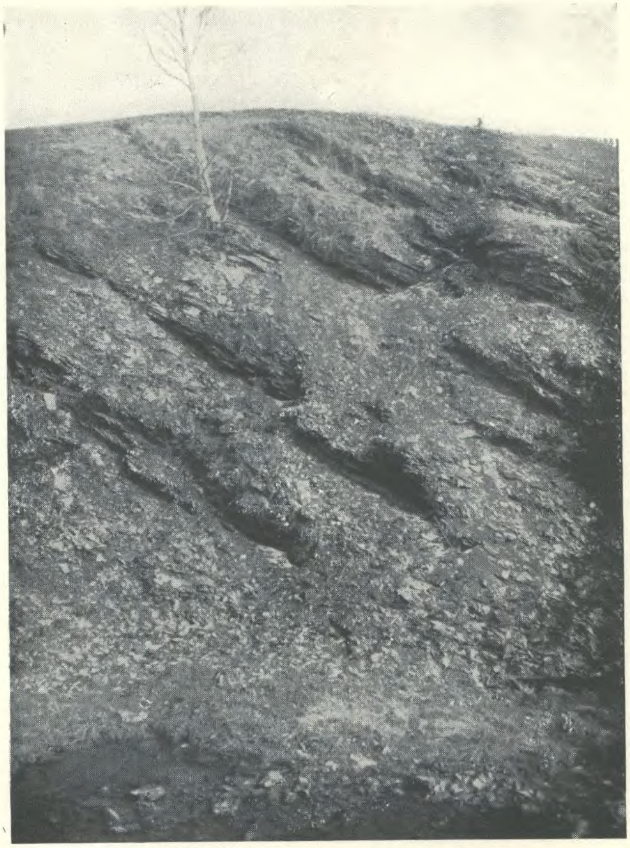
TABLE I

Summary of Logs

Hole No.	Depth of hole	Over-burden	Sand-stone and conglom-erates	Bituminous Shale — Oil Yield (gallons per ton)						
				0-5	5-10	10-15	15-20	20-25	25-30	35-40
	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
1	404	25	92	138	123	11	10	5	...	...
2	85	85	...	...	...	...	...	...	...	...
4	414	21	25	322	19	9	10	5	3	...
5	302	7	30	203	33	12	7	10	...	...
6	254	12	5	224	13	...	...	...	...	...
7	306	22	39	190	30	17	...	5	3	...
8	206	26	...	128	45	7	...	...	...	...
9	199	5	...	104	75	15	...	...	...	...
10	125	...	1	70	22	22	10	...	...	...
11	198	6	...	160	27	5	...	...	...	...
12	302	13	16	156	91	19	7	...	...	...
13	200	18	58	124	...	...	...	...	...	...
14	371	26	9	311	17	8	...	...	...	...
15	301	19	48	212	17	...	5	...	...	...
16	303	15	3	211	70	4	...	...	...	...
17	117	53	11	53	...	...	...	...	...	...
18	331	51	...	190	45	35	10	...	...	...
19	186	8	11	167	...	...	...	...	...	...
20	246	59	...	83	64	34	6	...	...	...
21	205	44	23	111	20	7	...	...	...	...
22	300	125	71	94	10	...	...	...	...	...
23	300	11	26	263	...	...	...	...	...	...
24	80	...	80	...	...	...	...	...	...	...
25	299	22	10	267	...	...	...	...	...	...
26	445	10	60	375	...	...	...	...	...	...
28	448	...	126	200	112	...	10	...	...	...
29	115	23	44	48	...	...	...	...	...	...
30	343	7	123	213	...	...	...	...	...	...
31	550	242	88	141	64	15	...	...	...	...
32	322	...	29	205	63	25	...	...	...	...
33	549	3	46	254	163	30	33	11	7	2
34	454	25	27	273	87	32	10	...	...	...
35	500	16	47	192	135	88	22	...	...	...
36	324	3	39	163	63	37	13	6	...	...
37	297	3	18	214	47	15	...	...	...	...
Totals	10,381	1,005	1,205	6,059	1,455	447	153	42	13	2

From the above summary and from a study of overburden conditions as indicated by the accompanying topographical map (Figure 1), it is clear that production of petroleum from oil shales of the Rosevale area cannot be considered as economically feasible.

A. Test pit, oil shale, Taylor Village, New Brunswick.



B. Oil-shale outcrop, Frederick Brook, Albert Mines, New Brunswick.

SECTION II

EXPLORATION OF OIL SHALES IN THE TAYLOR VILLAGE AREA

(F. J. Alcock)

In 1865, some 2,000 tons of bituminous shale was removed from Taylor Village and shipped to the United States, selling there at the rate of $6 a ton. In consideration of this fact it was decided, towards the conclusion of the drilling work carried out during the summer of 1942 at Rosevale, to put down a few holes in Taylor Village to explore the shales from which the shipment had come.

These shales are exposed on the west bank of the Memramcook River in Westmorland county, opposite Upper Dorchester. The exposures consist of grey shales, gritty shales, and a little grey sandstone, all belonging to the Albert formation of Lower Mississippian age. To the west these beds are overlain unconformably by a thin veneer of reddish conglomerate having a limestone matrix. This latter formation is of Pennsylvanian (Hopewell) age.

The area over which the Albert shales are exposed at Taylor Village has a length in a north-south direction of about one mile and a width in an east-west direction of about one-half mile. In the northern part the beds lie almost horizontally or with a slight dip to the northwest, while in the neighbourhood of the road from Upper Dorchester to Taylor Village, the dips are to the southeast at angles of from 20 to 60 degrees. The major structure in the shales, therefore, is an anticline whose axis trends northeast.

Drilling was carried out from July 16 to August 11. Seven holes with an average length of 150 feet and a total footage of 1,052 were put down as nearly as possible normal to the bedding of the shales. The overburden, consisting of drift and weathered shale, has an average thickness of 21 feet. The number of assays made was 124.

TABLE II

Summary of Logs

(Gallons per Ton of 2,000 Pounds)

Hole No.	Length, ft.	Number of assays	Depth of over-burden, ft.	Average oil content (gals.)	Footage of various grades				
					0-5 (gals.)	5-10 (gals.)	10-15 (gals.)	15-20 (gals.)	20+ (gals.)
61	150	18	27	6·4	20	98	5	....	....
62	152	13	29	7·0	43	53	27	....	....
63	151	20	17	6·0	36	73	25	....	....
64	150	18	18	5·7	60	72	....	....	....
65	150	20	25	8·7	40	35	30	20	....
66	149	18	15	6·1	52	72	5	....	5
67	150	17	15	1·8	130	5	....	....	....

Shale of 20-gallon grade was found in only one hole, No. 66. A 5-foot section of core from this hole assayed 22·2 gallons, but the sections immediately above and below averaged only 9·0 and 7·8 gallons respectively, and the average for the entire hole was 6·1 gallons. In hole No. 65, 20 feet averaged 15·8 gallons, but this footage represents three bands separated from each other by leaner material of less than 10-gallon average; this hole gave the best results of any in the area, the part represented by footage 45 to 140 averaging 10·3 gallons. The average over the whole area examined was about 6 gallons. It is quite evident from the above results that the oil content of the shales is, therefore, too low for them to be of commercial importance as a source of petroleum.

SECTION III

EXPLORATION OF OIL SHALES IN THE ALBERT MINES AREA

(F. J. Alcock)

LOCATION

The Albert Mines oil shale area is in Albert county, about 4 miles southwest of the town of Hillsborough and 20 miles south of Moncton. It is on the Salisbury and Albert branch of the Canadian National Railway, and a good road, branching off from the Hillsborough to Albert highway, traverses it.

AREA AND TOPOGRAPHY

The zone where oil-bearing shales here form the surface rocks has a length in a northeast direction of about one mile and a width in a northwest direction of about three-quarters of a mile. Part of this shale consists of very low-grade material, and part of the area is covered by swamp. The area, as a whole, is a rolling to hilly country traversed in a northeast direction by Frederick Brook, whose valley is steeply entrenched immediately along the brook to a depth of 50 to 80 feet beneath the surrounding flatter country. Most of the region is still wooded.

HISTORY

The region came into prominence in 1849, with the discovery in the bed of Frederick Brook of an outcrop of solid bitumen to which the term Albertite or locally "Albert coal" was given. Between this date and 1880 this material was mined and shipped to the United States, where it was used in the manufacture of illuminating gas. It occurred as a vein cutting across the area in an east-west direction. Later, interest was aroused in the possibilities of the shales of the surrounding region as a source of petroleum. Samples were quoted as running over 40 gallons to the ton, but no systematic work was carried out to definitely determine the average grade. Dr. W. J. Wright, in Memoir 129 "Geology of the Moncton Map-area", published by the Geological Survey in 1922, was the first to point out that the shales vary greatly in their oil content, ranging from rich oil shales to barren shales, and that the assays of a few selected samples did not at all represent the real average value.

WORK OF 1942

Drilling operations to test the area began on July 17, and continued until December 24. The area drilled consists of the part in which the richer shales outcrop and is, roughly, a square with sides 2,400 feet long. Thirty-six holes were put down with lengths varying from 99 to 1,004 feet. The total footage drilled was 13,122 feet. Three holes, Nos. 54, 56,

PLATE IV

A. Hole No. 75, Frederick Brook, Albert Mines, New Brunswick.

B. Hole No. 81, Albert Mines, New Brunswick.

and 59, have lengths of 788, 1,004, and 1,000 feet respectively. Aside from these three deeper holes, the average length of the remaining holes is 313 feet.

Twenty-three holes were put down at angles to the vertical in an endeavour to cut the beds as nearly as possible at right angles to the stratification. The remaining thirteen holes were sunk vertically with an average depth from the surface of 312 feet. Neglecting the three deep holes referred to above, the average vertical depth reached by the other thirty-three holes was 269 feet. Eleven holes were put down along Frederick Brook, nine north of the brook, and the remaining sixteen south of the brook. Numbers 40, 43, 44, 45, 46, and 56, north of the brook, are in woods; the remaining holes are in open country. The lowest drilling site, that of No. 54, has an elevation above sea-level of 249 feet. The highest, that of No. 42, south of the brook, has an elevation of 405 feet. The highest drill site north of the brook is that of No. 56, with an elevation of 401 feet.

The cores were assayed in the field, samples being taken from each 5-foot length. The number of core samples run was 2,384. Of this number only sixteen ran over 30 gallons, and only some sixty over 25 gallons to the ton. The highest value was 41·6 gallons for 5 feet from hole No. 38. Table III, pages 14 and 15, summarizes the results.

GEOLOGY

The rocks of the area drilled consist of shales of the Albert formation, which also contains minor amounts of sandstone and a little limestone. The formation is of early Mississippian age. On the west it is in contact with Precambrian volcanic rocks that form a highland. To the north, northeast, and southwest, the shales are overlain by conglomerate of the Moncton group, and to the southeast a conglomerate of Pennsylvanian (Hopewell) age rests unconformably with gentle dips on both the Moncton and Albert beds.

The Albert shales and overlying Moncton beds are thrown into a major anticline whose axis trends along Frederick Brook. As a result, the beds on the northwest side of the brook dip mainly to the northwest and those on the southeast side dip mainly to the southeast. The anticline has a pitch to the southwest upstream. The shales are also greatly deformed by dragfolding and faulting.

The shales vary in colour from grey and bluish grey to brown, brown-grey, and black, and in composition from soft varieties to gritty ones. Some are massive, but bedding planes are usually well marked. The highest oil content is in shales that give a brown streak, and thin-bedded or "paper" shales and minutely contorted or "curly" shales are usually high-grade types. Outcrop samples commonly run higher in oil than those from the same beds that are fresh and unweathered. The reason for this is, apparently, that weathering removes certain constituents, such as lime, leaving behind the bitumen, which accordingly shows as a higher

TABLE III

Summary of Logs

Hole No.	Bearing	Angle from horizontal, degrees	Elevation, feet	Length, feet	Vertical depth, feet	Over-burden, feet	Footage of various grades					Average for entire hole, gallons
							0-5 (gal./ton)	5-10 (gal./ton)	10-15 (gal./ton)	15-20 (gal./ton)	20+ (gal./ton)	
38	S.50° E.	45	352	400	282	33	130	21	55	55	100	12·8
39	N.5° E.	40	323	450	290	35	295	80	50	....	....	4·4
40	S.30° E.	45	370	401	285	32	25	125	124	65	30	11·9
41	N.16° W.	45	368	175	12	25	40	15	40	20	35	12·7
42	N.15° W.	45	405	435	312	32	185	125	40	40	13	7·6
43	S.35° E.	45	309	302	214	50	97	75	45	20	15	8·0
44	S.50° E.	60	321	249	216	21	5	63	110	40	10	11·3
45	S.55° E.	50	341	249	193	102	8	40	79	20	....	11·1
46	N.10° W.	50	323	350	270	35	15	135	135	30	....	10·3
47	N.20° W.	50	341	250	190	26	25	100	55	25	19	11·0
48	N.25° W.	50	340	250	190	26	120	10	25	24	45	9·9
49	N.25° E.	55	300	200	168	27	54	90	10	19	....	7·2
50	E.	50	307	97	75	15	67	5	....	10	....	5·8
51	N.32° E.	55	281	250	206	11	42	54	37	59	47	14·3
52	N.27° E.	60	276	500	435	0	69	158	133	108	32	11·6
53	N.50° E.	80	263	305	300	11	....	131	84	61	18	11·9
54	....	90	249	788	788	21	365	228	129	20	25	7·0

55..........	N.15° E...	45	328	403	283	33	100	85	90	65	30	10·4
56..........	S.45° E....	45	401	1,004	790	17	240	410	250	55	26	9·0
57..........	....	90	328	400	400	25	50	75	95	45	110	14·1
58..........	N.40° E....	45	289	400	332	37	97	79	64	63	60	12·9
59..........	N.15° W...	45	360	1,000	775	27	253	370	225	80	35	9·0
60..........	N.15° W...	45	312	431	300	30	251	110	30	10	....	5·1
71..........	....	90	323	250	250	25	65	80	45	20	15	9·0
72..........	....	90	319	150	150	20	55	30	30	10	5	7·8
73..........	....	90	349	395	395	20	110	40	85	60	80	12·5
74..........	....	90	285	362	362	26	57	129	60	50	40	10·4
75..........	....	90	289	499	499	28	176	170	65	35	25	8·0
76..........	....	90	313	270	270	18	122	95	25	5	5	6·0
77..........	....	90	314	350	350	70	50	90	80	30	30	11·4
78..........	N.16° W...	45	329	251	177	36	93	46	40	10	25	9·2
79..........	N.16° W...	60	329	300	260	21	110	89	30	40	10	8·0
80..........	....	90	300	162	162	58	15	55	30	5	....	8·9
81..........	....	90	357	263	263	23	108	70	40	10	12	8·0
82..........	....	90	361	250	250	30	140	40	35	5	....	5·3
83..........	....	90	294	334	334	19	28	91	79	48	69	13·4

percentage in the weathered rock. Higher grade shale is lighter than low-grade material. Specific gravity tests were run on five core samples with the following results:

	Specific gravity
6·4-gallon shale	2·37
9·1 " "	2·23
11·4 " "	2·22
20·6 " "	1·97
36·5 " "	1·83

It, therefore, takes about 15 cubic feet of average-grade solid material to weigh a ton.

INTERPRETATION OF DRILLING RESULTS

From the point of view of its oil content the Albert shale formation in this area is made up of three main stratigraphic divisions. The upper is a zone whose oil content averages less than 5 gallons to the ton. A grey sandstone 10± feet thick occurs 350± feet stratigraphically above the base of this zone, and is the best horizon marker in the entire formation. Above the sandstone, a thick series of grey shales low in oil grades up into the overlying Moncton beds. A good section of these beds is seen in the creek bed south of hole No. 39. The grey sandstone and the lean beds immediately below it were cut in holes Nos. 39, 56, and 60.

The middle division was cut by the two deep holes, Nos. 56 and 59, and a third section across it is obtained by combining the information from holes Nos. 58, 74, 51, 52, 53, and 54 (*See* longitudinal section along Frederick Brook, Figure 4). This zone has a stratigraphic thickness of 700± feet. Its average oil content, as obtained by averaging the results of all the wells that intersect or partly intersect it, is 10·6 gallons. Below this zone, the third division consists of bluish grey shales with an average oil content, where cut by the three deep holes, of less than 5 gallons to the ton. It is possible that, below the zone explored by drilling, beds running more than this figure may occur.

As a result of the anticlinal structure referred to in the section on geology, and of the erosion which has removed the crest of the fold, the beds of the richer middle zone are brought to the surface along Frederick Brook. The surface width of this exposed belt in a northwest direction averages 1,600 feet. The eastern border is a north-south fault between holes Nos. 59 and 60, to the east of which the lower grade shales and sandstone of the upper zone have been dropped down so that they then form the surface rocks. The western limit is near hole No. 39, where, owing to the western pitch of the anticline, the upper lean zone here also forms the surface beds. The exposed length of the middle zone is, therefore, around 2,400 feet. The vertical depth averages at least 400 feet. There is available, therefore, on the basis of 15 cubic feet to the ton approximately 100,000,000 tons of 10·6-gallon shale above the 400-foot level. This would be available by open-cut mining, assuming vertical walls, and more could be obtained by following the zone down by underground mining beneath the lean beds on the flanks of the anticline. The overburden would probably average around 10·6 gallons also. The amount of drift in most places is slight, the surface material consisting largely of broken and weathered shale.

Part of the middle zone referred to above runs considerably above the 10·6-gallon average, but, when an attempt is made to compute tonnages of higher grade material available, difficulties, for a number of reasons, arise.

(1) The same beds vary in their oil content both along the strike and down the dip.

(2) In many of the holes the drill cut the beds at low angles to the bedding, in places ran for considerable distances parallel to the stratification, and certain sections of core showed that the dips became reversed. Core lengths of high-grade material in such cases do not mean similar real thicknesses of such high-grade value. It may merely mean a thin rich zone followed by the drill at a low angle or repeated by folding.

(3) The lack of definite horizon markers in the middle oil-shale zone makes it impossible to definitely correlate beds, to work out details of structure, and hence calculate tonnages with confidence.

Two methods of calculation to determine tonnages of richer material may be employed, both of which have their advantages and their disadvantages. One may endeavour to use stratigraphic zones, or, secondly, one can disregard stratigraphy and structure entirely and use the drilling results to determine mass averages. The former of these methods allows a more accurate estimate to be made of the average oil content of the beds, and gives also some idea as to what may be expected beyond the bounds of the territory actually blocked out by the drilling. The latter method affords definite information on the tonnage blocked out, but without very closely spaced drilling, calculated averages, for the reasons already pointed out, may be far from actual averages. An attempt is, therefore, made below to use the stratigraphic method to estimate the amount of higher grade material.

A restricted area surrounding hole No. 51 shows considerable thickness of 20+ gallon shale and a number of holes more closely spaced than those in the rest of the area were put down to explore this belt. Although, as stated above, horizon markers are lacking, and beds vary in their oil content both along the strike and the dip, nevertheless it is reasonable to assume that in a limited area, a few hundred feet across, the high-grade beds cut in the various holes probably represent the same stratigraphic zone. From the angle of bedding to core axis, an attempt has been made to infer the stratigraphic thickness represented in the following holes:

Hole No.	Footage of richer beds	Core length, feet	Probable stratigraphic thickness, feet	Average oil content, gallons
38	33—250	217	90 ±	20·1
51	86—181	95	80 ±	20·8
52	0— 45	45	45 ± (top missing)	22·6
58	150—300	150	100 ±	20·3
73	145—275	130	80 ±	19·2
74	185—290	105	60 ±	17·0
75	335—395	60	35 ±	18·0
Average	....	....	70 ±	19·7

The length of this zone in a southwest direction from where it comes to the surface at hole No. 52 to beneath No. 58 is 600 feet. No matter what the structure is, it is probable that the dimension normal to this is at least 600 feet also. This would make a tonnage of $\frac{600 \times 600 \times 70}{15}$ or 1,680,000 tons of 19·7-gallon material. In addition, along the south limb of the anticline, 40-foot widths of 20+ gallon material were cut in holes Nos. 41, 42, 48, and 59. Assuming this to be a belt with a strike length of 1,000 feet and that it maintains its value down the dip for a distance of 250 feet, there would be an additional tonnage of $\frac{1,000 \times 250 \times 40}{15}$ or 666,000 tons of 20-gallon material. On the north flank of the anticline the zones of such material are too thin and discontinuous to be considered separately. The probable tonnage of material averaging 20 gallons that might be expected to be recoverable is, therefore, around 2,350,000 tons and most of this would have to be secured by selective mining. To take out any considerable proportion of this by open-cut methods would involve excavating lower grade material that, it is estimated, would reduce the average grade to about 12 to 14 gallons.

The second method referred to above, that of using the drilling assays to determine mass averages, has been employed by Dr. H. M. A. Rice of the Geological Survey, by use of a model of the area to work out tonnages of several grades. The writer has checked his figures and believes that his is as fair an estimate as can be made by this method from the data available. Dr. Rice concludes that there is a probable tonnage, of 2,111,100 tons of 18-gallon material, and 3,043,700 tons of 15-gallon material, the latter including the former. The blocked-out area will possibly supply 22,363,700 tons of material that will average 12 gallons to the ton, including the richer material referred to above.

In summary, the writer is of the opinion that if a large tonnage of material capable of being mined by open-cut methods is required, one must be prepared to treat shales of from 10- to 12-gallon grade. Richer material of around 20 gallons to the ton is present in an amount of the order of magnitude of 2,000,000 tons. Most of this would have to be secured by selective mining if it were necessary to maintain this grade. Some 20,000,000 tons of 12-gallon material could be obtained by open-cut methods, and a block with vertical walls contains 100,000,000 tons of 10·6-gallon material.

SECTION IV

ANALYTICAL METHODS AND RESULTS

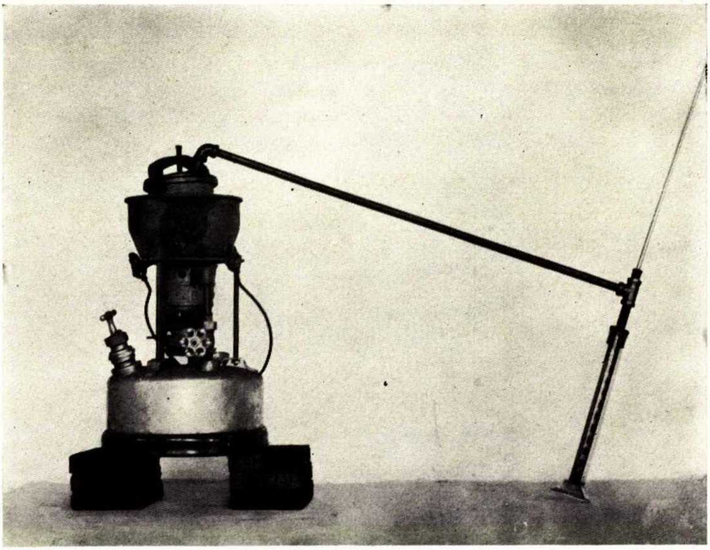
(A. A. Swinnerton)

(1) APPARATUS AND METHOD USED IN ASSAYING SAMPLES IN THE FIELD

As part of the plan for the exploration of the oil-shale areas in Albert and Westmorland counties, N.B., a field laboratory was set up for assaying the oil-shale samples obtained by core drilling.

This field laboratory was a frame building, 9 feet by 18 feet, provided with working benches on each side. Eight laboratory assistants were engaged and they were divided into two shifts, to keep pace with the drilling, which was continuous throughout the 24 hours.

PLATE V



Field assay retort.

A total of 3,387 samples were assayed: 854 from the Rosevale area, 134 from the Taylor Village area, and 2,399 from the Albert Mines area.

The drill cores on arrival at the laboratory were first logged by the engineer in charge and then split in a core splitter, one-half being crushed for assay purposes, and the other half returned to the core box to serve as a reference sample. The general procedure was to take 5-foot sections for assay unless there was a marked change of rock in any particular section. Due to the low grade of most of the drill cores from the Rosevale area, alternate 5-foot sections were assayed, but where it appeared that the shale would yield more than 5 gallons per ton every section was assayed. Owing to the better quality of most of the shale from Albert Mines all the sections from this area were assayed.

The retorting apparatus is what is known as the United States Bureau of Mines Field Assay Retort, a full description of which is given in United States Bureau of Mines Bulletin No. 210. Briefly, it consists of a cast-iron, pint-size mercury retort with cover, and a $\frac{1}{4}$-inch offtake pipe 28 inches long terminating in a $\frac{1}{4}$-inch T-piece, one arm of which is connected to a 100-c.c. glass measuring cylinder in which the oil is collected, and the other to a glass tube 24 inches long that acts as a reflux condenser.

The crushed shale is weighed into the retort, the lid fastened on by a clamp and rendered oil-tight with an asbestos gasket, and the apparatus connected up. A gasoline heater, such as a 'Plumber's Fire Pot', is used as a source of heat and the heating rate adjusted so that the oil comes off as rapidly as possible, care being taken to see that no tar fog is produced as a result of too rapid distillation. Heating is continued until no more oil is given off, the time required for a distillation varying from 1 to 2 hours, according to the grade of the shale. Oil and water collect in the graduated cylinder, and when the distillation is finished the volume of oil obtained is read off.

The yield of oil in gallons per ton (2,000 lb.) is calculated as follows:

$$\frac{\text{C.c of oil} \times 200}{\text{Wt. of shale in grams.}}$$

(2) ASSAYS OF MISCELLANEOUS OIL-SHALE SAMPLES

During the course of the drilling operations, samples were taken from various accessible outcrops and such old tunnels as it was possible to enter, in order to compare the assays of outcrop samples and drill cores. It will be noted that several of the grab samples give a higher oil yield than the representative samples obtained by core drilling.

(a) Rosevale Area

	Gallons per ton
Working III, Jonah Creek	
Left side, 25 feet from portal	
Top 2 feet	7·0
Bottom 2 feet	3·5
Right side, 75 feet from portal	
Top 3 feet	5·3
Bottom 3 feet	4·7
Working IV, Baltimore Creek	
Left side, 15 feet from portal	
Top 3 feet	1·5
Bottom 3 feet	4·1
East crosscut	
Top 3 feet	11·2
Bottom 3 feet	12·0
Northwest Branch—right side	
Top 3 feet	11·2
Bottom 3 feet	3·5

	Gallons per ton
Working V, West Branch Turtle Creek (West bank)	
Right side, 18 feet from portal	
Top 2½ feet	9·4
Bottom 2½ feet	17·1
Right crosscut 48 feet from portal	
Top 2½ feet	15·0
Bottom 2½ feet	12·6
Left side, 77 feet from portal	
Top 3 feet	12·0
Bottom 3 feet	16·5
Working XV, West Branch Turtle Creek (East bank)	
Grab sample from old dump (weathered)	39·5
Tunnel, East Branch Turtle Creek (Baisley Brook)	
Left side, 40 feet from portal	
Top 3 feet	20·0
Bottom 3 feet	5·9
Left side, 80 feet from portal	
Top 3 feet	26·6
Bottom 3 feet	15·9
Left side, 8 feet from portal	
Top 3 feet	10·6
Bottom 3 feet	3·5
Tunnel north of site of former Maritime Eduction Co. plant	
At portal right side, 5 feet	8·8
Left branch at face	
Upper 3 feet	9·4
Lower 3 feet	8·8
End of tunnel at face	
Upper 3 feet	8·8
Lower 3 feet	14·8
Tunnel north of F. Stevens' house, Rosevale	
Grab sample from dump	42·3
Shale hollow	
Grab sample from dump at old workings	37·0

(b) Taylor Village Area

Outcrop sample from farm, Alvin Taylor	30·7
Weathered sample from dump at test pit	35·4
Sample 500 feet north of highway Taylor Village—Upper Dorchester	25·3
Sample No. 1	2·7
Sample No. 2	4·1
Sample No. 3	8·9
Sample No. 4	11·8
Sample No. 5:	
Upper 4 feet	2·9
Middle 3 feet	12·9
Lower 4 feet	23·6

(c) Indian Mountain

Best-looking samples from test pit at west end near main road:	
Sample No. 1	11·8
Sample No. 2	8·4

(d) Albert Mines Area

As it was locally believed that the dumps from the old Albertite workings were composed of rich shale, representative surface samples were taken from three of the largest as follows:

	Gallons per ton
Main Shaft Dump	
Sample No. 1	3·4
Sample No. 2	3·4
Sample No. 3	3·4
Sample No. 4	1·7
Sample No. 5	5·1
Victoria Shaft Dump	
Sample No. 1	5·1
East Shaft Dump	
Sample No. 1	6·3
Sample No. 2	12·6
Sample No. 3	8·0
Sample No. 4	6·3
Sample No. 5	5·7
Sample No. 6	7·4
"Breccia" Shale, float sample	
Near Bed No. 1, Frederick Brook	21·4
Curly Shale, float sample	
Near Bed No. 1	42·3
Shale	
From pile near Bed No. 5	38·4

(3) ANALYSES OF COMPOSITE SAMPLES OF SHALE OIL OBTAINED FROM DISTILLATION OF DRILL CORES

(a) Rosevale Area

Distillation, Hempel Method (Dehydrated)

Specific gravity at 60°F............ 0·884
Sulphur, % by weight:............ 0·58
Water, % by vol. (A.S.T.M.):...... —
Water and sediment, % by vol.: (by centrifuge)............... Trace

Degrees A.P.I. at 60°F.:...........28·6
Colour:.. ....Brownish black
Cloud point, °F.:................ —
Pour point, °F.:................ 55

Viscosity: Saybolt Universal, at 70°F.—secs; at 100°F...................... 49 secs.

Distillation, Hempel Method (Dehydrated)

Dry distillation: Barometer: 762 mm.; First drop: 40°C (104°F)

Temperature °C	Per cent cut	Cum. per cent	Specific gravity of cut	Degrees A.P.I. of cut	Correlation Index	Viscosity Say. Univ. at 100°F.	Cloud test °F.	Temperature °F.
Up to 50	......	......	......	......	......	......	......	Up to 122
50— 75	2·0	2·0	0·708	68·4	......	......	......	122—167
75—100	1·7	3·7	0·734	61·3	28	......	......	167—212
100—125	3·1	6·8	0·754	56·2	28	......	......	212—257
125—150	4·9	11·7	0·771	52·0	29	......	......	257—302
150—175	5·2	16·9	0·792	47·2	32	......	......	302—347
175—200	4·6	21·5	0·812	42·8	35	......	......	347—392
200—225	5·6	27·1	0·829	39·2	38	......	......	392—437
225—250	6·7	33·8	0·844	36·2	40	......	......	437—482
250—275	6·9	40·7	0·859	33·2	42	......	......	482—527

Vacuum distillation at 40 mm.:

Temperature °C	Per cent cut	Cum. per cent	Specific gravity of cut	Degrees A.P.I. of cut	Correlation Index	Viscosity Say. Univ. at 100°F.	Cloud test °F.	Temperature °F.
Up to 200	4·4	45·1	0·872	30·8	44	41	15	Up to 392
200—225	6·9	52·0	0·882	28·9	45	51	35	392—437
225—250	7·6	59·6	0·897	26·3	49	68	55	437—482
250—275	7·3	66·9	0·911	23·8	52	109	70	482—527
275—300	8·7	75·6	0·929	20·8	58	230	85	527—572

Carbon residue of residuum: 9·8% Carbon residue of crude: 2·3%

Approximate Summary

—	Per cent by volume	Specific gravity	Degrees A.P.I.	Viscosity, Say. Univ. at 100°F.
Light gasoline	3·7	0·720	65·0	
Total gasoline and naphtha	21·5	0·774	51·3	....
Kerosene distillate	....	....	....	
Gas oil	26·7	0·853	34·4	Below 50
Nonviscous lubricating distillate	13·3	0·881—0·908	29·1—24·3	50—100
Medium lubricating distillate	7·9	0·908—0·924	24·3—21·6	100—200
Viscous lubricating distillate	6·2	0·924—0·938	21·6—19·4	Above 200
Residuum	23·8	0·975	13·6	....
Distillation loss	0·6	....	....	....
Base of crude	Shale Oil (Intermediate) (Wax bearing)			

(b) Albert Mines Area

Characteristics of Crude

Specific gravity at 60°F............. 0·861
Sulphur, % by weight.............. 0·75
Water, % by vol. (A.S.T.M.):...... Trace
Water and sediment, % by vol.:
(by centrifuge)................. —

Degrees A.P.I. at 60°F........... 32·8
Colour.................Brownish black
Cloud point, °F:................. —
Pour point, °F:.................. 60

Viscosity: Saybolt Universal, at 70° F — secs.; at 100° F. .... 41 secs.

Distillation, Hempel Method (Dehydrated)

Dry distillation: Barometer: 759 mm.; First drop: 38 °C. (100°F.)

Temperature °C	Per cent cut	Cum. per cent	Specific gravity of cut	Degrees A.P.I. of cut	Correlation Index	Viscosity, Say. Univ. at 100°F.	Cloud test, °F.	Temperature °F.
Up to 50.....	....	....	....	....	....	....	....	Up to 122
Up to 75.....	2·6	2·6	0·680	76·6	....	....	....	Up to 167
75—100.....	2·3	4·9	0·717	65·9	20	....	....	167—212
100—125.....	4·7	9·6	0·739	60·0	21	....	....	212—257
125—150.....	5·9	15·5	0·762	54·2	25	....	....	257—302
150—175.....	3·8	19·3	0·785	48·8	29	....	....	302—347
175—200.....	5·7	25·0	0·804	44·5	32	....	....	347—392
200—225.....	5·7	30·7	0·823	40·4	35	....	....	392—437
225—250.....	5·2	35·9	0·839	37·2	37	....	....	437—482
250—275.....	7·2	43·1	0·851	34·8	38	....	....	482—527

Vacuum distillation at 40 mm.:

Up to 200....	4·4	47·5	0·864	32·3	40	38	15	Up to 392
200—225.....	7·5	55·0	0·872	30·8	40	45	35	392—437
225—250.....	9·0	64·0	0·883	28·8	42	56	55	437—482
250—275.....	7·5	71·5	0·898	26·1	46	82	75	482—527
275—300.....	8·3	79·8	0·912	23·7	50	144	85	527—572

Carbon residue of residuum: 5·3%; Carbon residue of crude: 1·0%

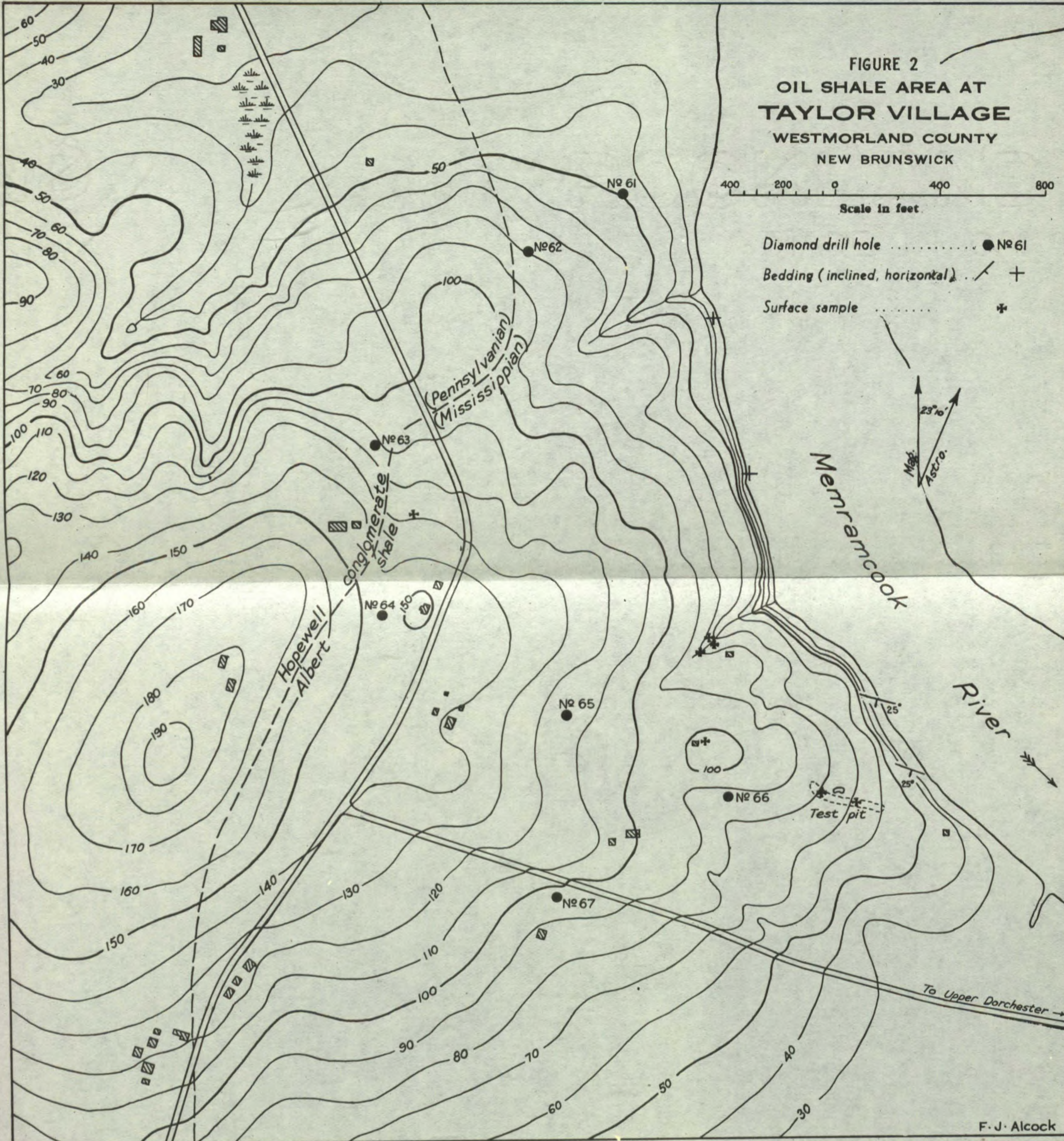
Approximate Summary

—	Per cent by volume	Specific gravity	Degrees A.P.I.	Viscosity, Say. Univ. at 100°F.
Light gasoline............	4·9	0·697	71·5	
Total gasoline and naphtha............	25·0	0·758	55·2	....
Kerosene distillate............	5·7	0·823	40·4	
Gas oil............	24·0	0·857	33·6	Below 50
Nonviscous lubricating distillate............	15·3	0·876—0·902	30·0—25·4	50—100
Medium lubricating distillate............	9·8	0·902—0·919	25·4—22·5	100—200
Viscous lubricating distillate............	....	....	....	Above 200
Residuum............	19·5	....	....	....
Distillation loss............	0·7	....	....	....
Base of crude............	Shale Oil (Intermediate) (Wax bearing)			

Remarks:

Reported by: H. McD. Chantler.


FIGURE 1
OIL SHALE AREA AT
ROSEVALE
ALBERT COUNTY
NEW BRUNSWICK
500 0 500 1000
Scale in feet
LEGEND
Diamond drill hole ● Nº 30
Holes drilled prior to 1942 O
Tunnel
Bedding (inclined)
Rock outcrop ×
To Turtle Creek station
To Prosser Brook
To Hillsborough
To Shenstone
Turtle Creek (West branch)
Baltimore Creek
Stuart Brook
Jonah Brook
Baisley Brook
Turner Brook
Bray Brook
East branch Turtle Brook
Site of Baltimore Plant
Baisley Tunnel
School
MONCTON CONGLOMERATE
ALBERT SHALES
PRECAMBRIAN
Mag.
Astron.
25° 30'
S.C. Ells
GEOLOGICAL SURVEY



GEOLOGICAL SURVEY

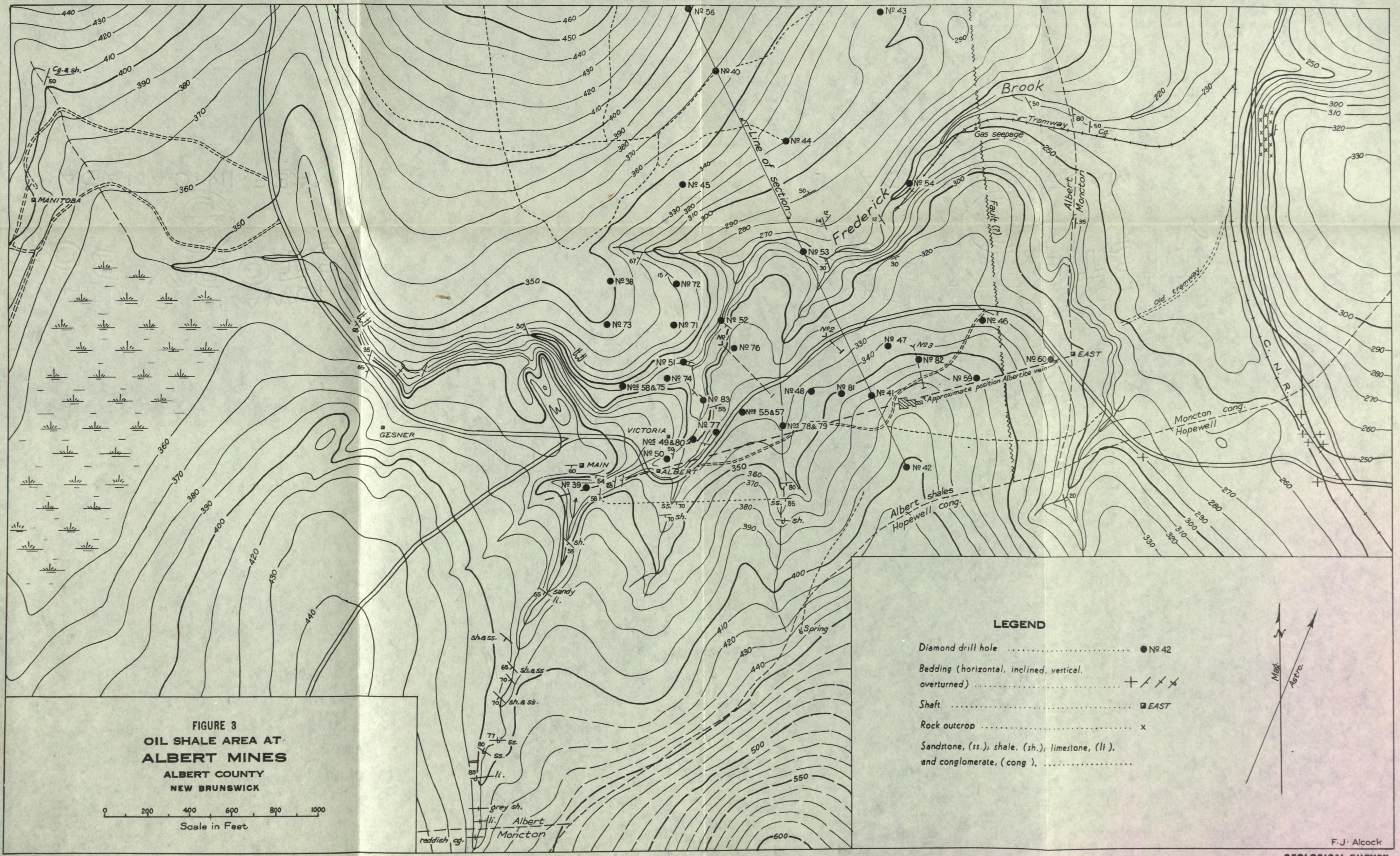


FIGURE 3
OIL SHALE AREA AT
ALBERT MINES
ALBERT COUNTY
NEW BRUNSWICK

GEOLOGICAL SURVEY

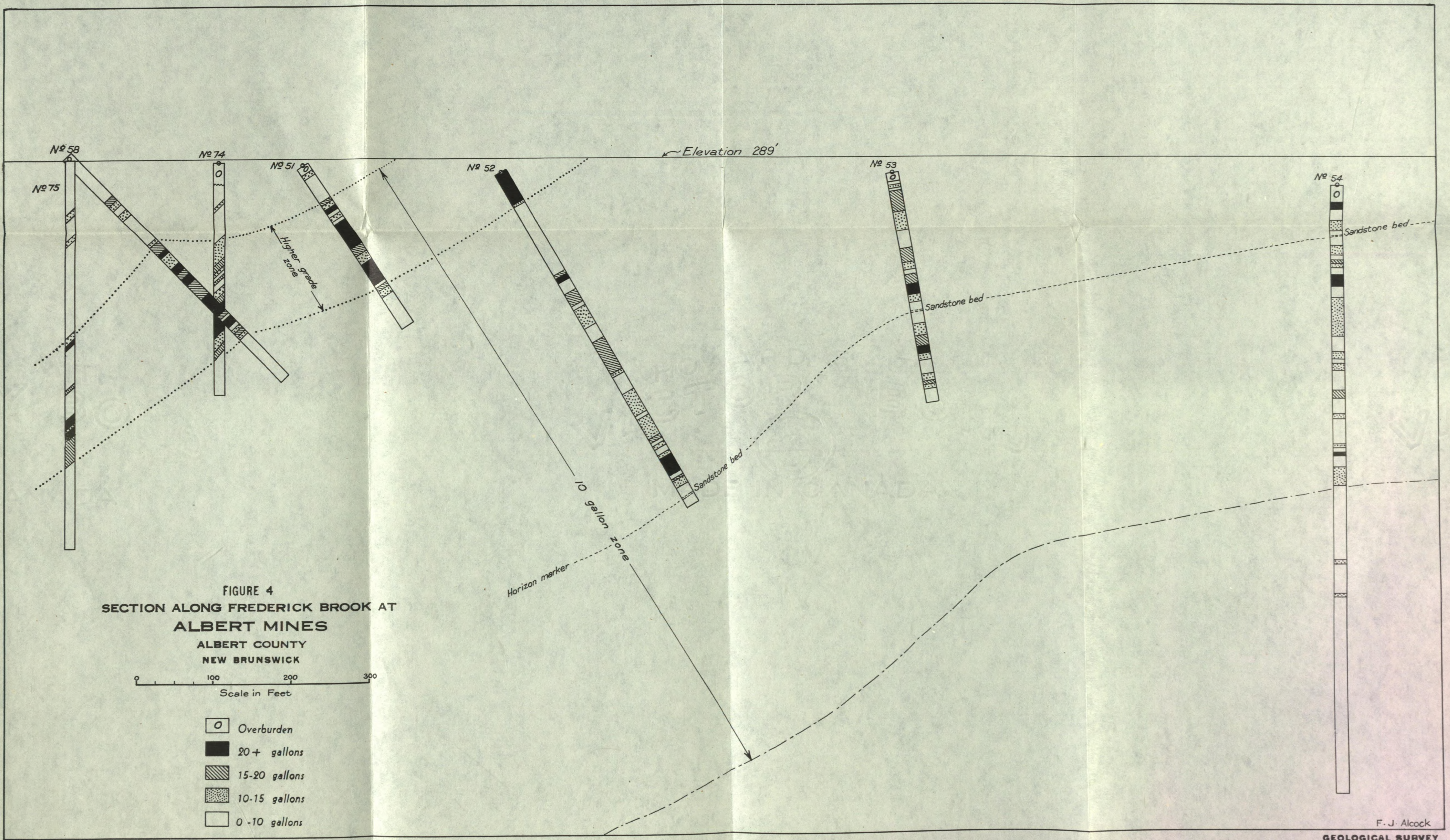


FIGURE 4
SECTION ALONG FREDERICK BROOK AT
ALBERT MINES
ALBERT COUNTY
NEW BRUNSWICK

GEOLOGICAL SURVEY

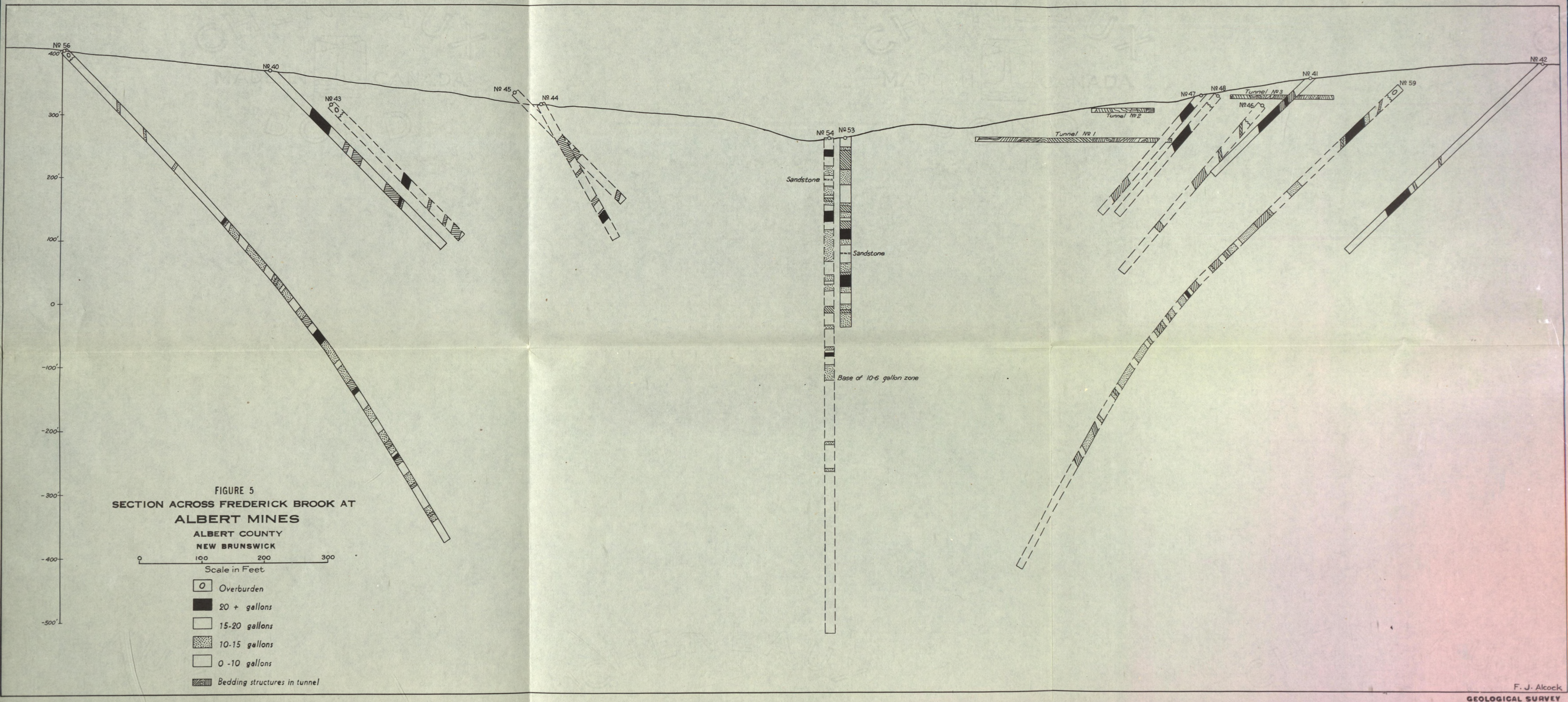


FIGURE 5
SECTION ACROSS FREDERICK BROOK AT
ALBERT MINES
ALBERT COUNTY
NEW BRUNSWICK