ERP/ERL 76-19(J)

Energy, Mines and Resources Canada — Énergie, Mines et Ressources Canada

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01-7987626

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J.C. Botham and J.R. Donaldson

Canadian Metallurgical Fuel Research Laboratory

March 1976

ENERGY RESEARCH PROGRAM
Energy Research Laboratories
Report ERP/ERL 76-19 (J)

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by

J.C. Botham* and J.R. Donaldson**

INTRODUCTION

This article is intended as a companion to one dealing with the coking coals of western Canada in the special issue of "Trends in Mining" published by the Northern Miner in May 1975.

The coking coals of eastern Canada present a sharp contrast with their counterparts located in western Canada, as may be gleaned from their respective generalities given in Table 1[1].

TABLE 1

General Comparison of the Coking Coals of Eastern and Western Canada

	Eastern Canada	Western Canada
Grade		
Ash content	Low	High
Sulphur content	High	Low
Rank	High volatile bituminous	Low-medium volatile bituminous
Geological Age	Carboniferous	Cretaceous
Coking Properties	High fluidity	Low fluidity
Physiographical and Geological Features	Extend with moderate pitch to unknown distances under the sea.	Steeply inclined, thickened and thinned, truncated by faults, very friable.
Type of Mining	Underground (submarine)	Largely strip mining

*Manager, Canadian Metallurgical Fuel Research Laboratory, **Coal Petrographer, Energy Research Laboratories, CANMET, Department of Energy, Mines and Resources, Ottawa, Canada.

Their differences, however, may be considered to be compatible for conventional coke-making which normally comprises the blending of low and high volatile coals for the production of high strength coke.

As blast furnace coke is the highest single conversion cost item in steel-making, this source of coal is of current national interest with regard to its use for coke-making at a proposed new integrated steel complex in Nova Scotia and also as a high volatile coking coal for use in central Canada and as an export commodity.

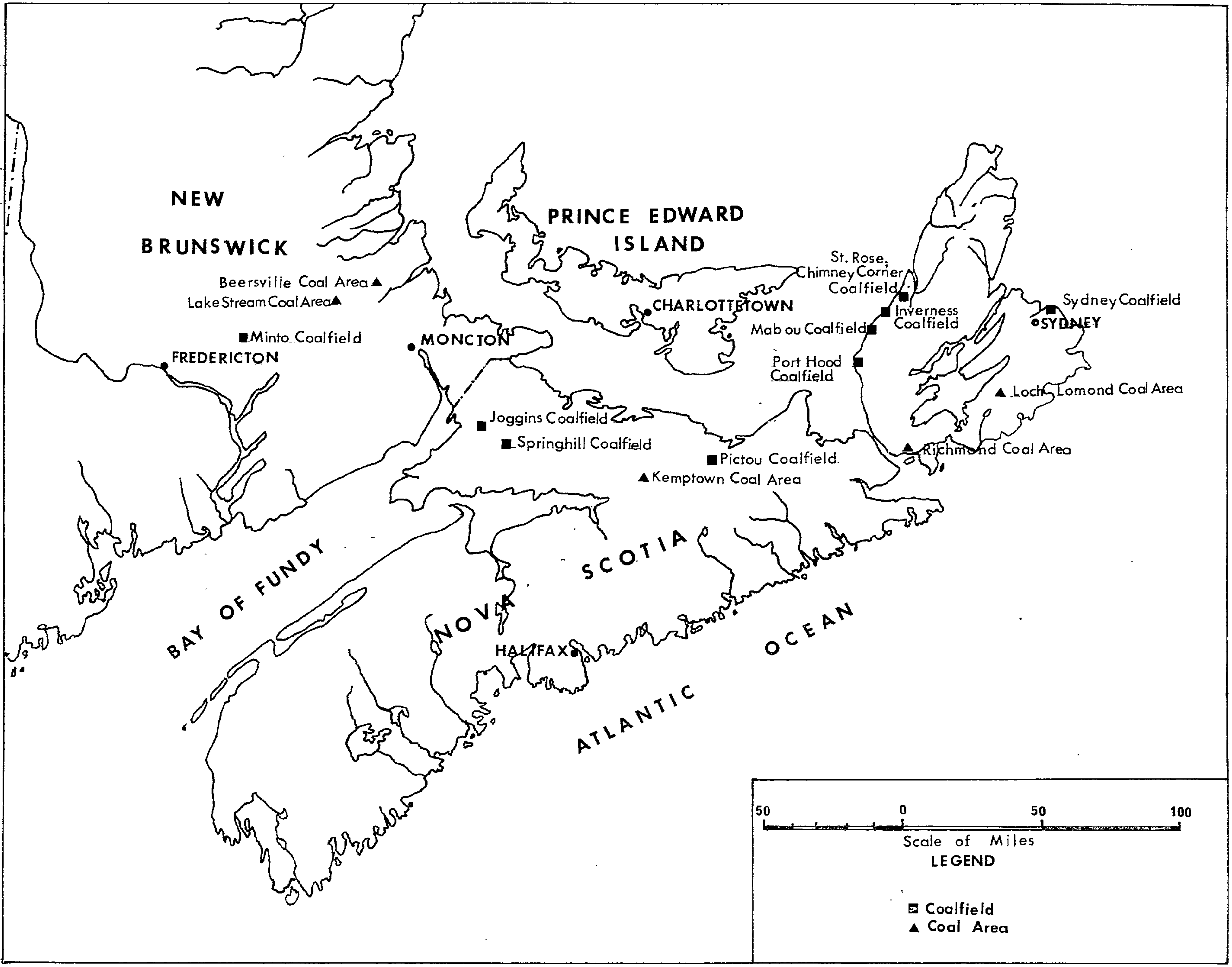
COAL DEPOSITS OF EASTERN CANADA

The presence of coal in eastern Canada was first reported by Mr. Nicolas Denys in work published in Paris in 1672[2] which made mention of the presence of coals on Cape Breton Island in the Province of Nova Scotia. It is interesting to note that there is a cairn erected in the town of Port Morien on that island which marks the location of the first coal mine in North America. Since that time, coal deposits have been discovered in other parts of Nova Scotia, New Brunswick and Newfoundland. Prince Edward Island is the only one of the Atlantic Provinces having no known coal deposits. Coal has been known in the Gaspe area of Quebec but is of no commercial significance. Some lignites of questionable commercial value are found in Northern Ontario, in the Hudson Bay Lowlands area and principally along the several rivers and tributaries draining into James Bay.

Dr. B.R. MacKay of the Geological Survey of Canada reported in 1947 that a total of 5.04 billion tons of probable coal reserves occur in New Brunswick and Nova Scotia with 97 percent of this amount located in Nova Scotia[3]. The coal is largely high volatile "A" bituminous in coal rank, although small quantities of high volatile "C" bituminous coal from the west coast of Cape Breton are also included.

The location of the coal deposits in Eastern Canada are given in Figures 1 and 2. Table 2 summarizes some of the salient aspects of the eastern Canadian coalfields, and Table 3 lists the producing mines and relevant statistics.

FIG. 1 COAL AREAS OF NOVA SCOTIA AND NEW BRUNSWICK



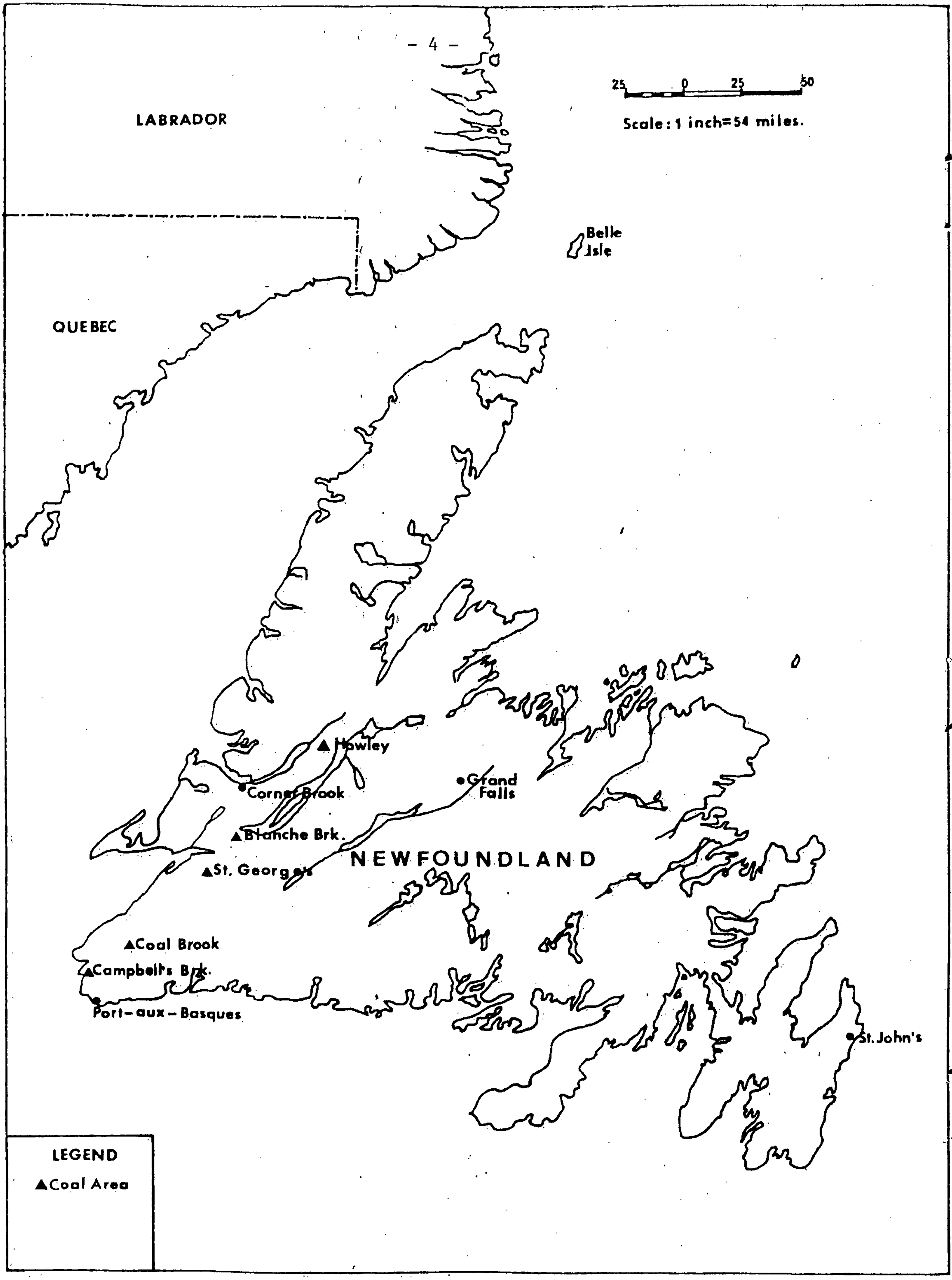


FIG. 2 COAL AREAS OF NEWFOUNDLAND

TABLE 2

General Features Of The Coals Of Eastern Canada[3]

Province (County)	Coalfield or Area	Rank (ASTM)	Recoverable* Reserves (X 10^6 tons)	Comments
Nova Scotia (Cape Breton)	Sydney	hvAb	1,340	- best source of coking coal in Eastern Canada
	Port Hood, Mabou, Inverness, St. Rose, Chimney Corner	hvCb	40	- non coking
	Richmond and Loch Lomond	hvAb	10	- reported to be coking coal but very limited in quantity
Nova Scotia (Pictou)	Thorburn and Stellarton	hvAb	26	- fair coking quality, but high in ash content
	Westville	mvb	21	- fair coking quality, higher in rank, lower in sulphur but high in ash content
Nova Scotia (Cumberland)	Springhill	hvAb	62	- good coking quality, but with mining difficulties
	Joggins	hvAb	44	- fair to poor coking quality, with high sulphur and ash content
New Brunswick	Minto	hvAb	50	- good coking quality, but excessively high sulphur content
	Beersville	hvAb	-	- thin seams
Prince Edward Island	-	-	-	- no known seams
Newfoundland	-	-	-	- spotty deposits of unknown extent and quality

* Reserves based upon coal seams not less than 3 feet in thickness to a maximum depth of 4000 feet.

TABLE 3

Coal Producing Mines Of Eastern Canada[4]

Operator and Head Office	Name of Mine Location and Representative	Type of Mine	Output (st)*	Chief Markets	Seam** Characteristics	Preparation Facilities	Remarks
NOVA SCOTIA							
SYDNEY COALFIELD							
Cape Breton Development Corporation	Lingan Mine Lingan, Nova Scotia	UG	452,375	Metallurgical and power generation	Rank: Hvb "A" 1 x 85 in. seam dip	Small percentage processed at Princess washplant	Two new longwalls to be started in 1975 will raise capacity to 2,000,000 tpy. Preparation plant being built nearby at Grand Lake
	No. 26 Glace Bay, Nova Scotia	UG	577,937	Metallurgical, industrial, domestic	Rank: Hvb "A" 1 x 85 in. seam dip	Vibrating screens cap. 300 tph	New conveyor system completed in 1974 and third longwall started. Plan for new tunnel to surface and load-out facility
	Princess Sydney Mines, Nova Scotia	UG	112,847	Domestic, industrial, and power generation	Rank: Hvb "A" 1 x 60 in. seam	Preparation plant with McNalley Pittsburg Baum Jig cap. 350 tph	
	Point Aconi, Nova Scotia.	Surface	71,728	Power generation	Rank: Hvb 1 x 8 ft seam dip	Not processed	Operation began in October 1974 replacing the Alder Point operation. Capacity in 1975 estimated at 225,000 tpy
INVERNESS COALFIELD							
Evans Coal Mines Limited	St. Rose, Nova Scotia	UG	26,035	Power generation, domestic	Rank: Hvb "B" 1 x 8 ft seam	Mechanical dry screening - oil treated cap. 50 tph	Plan to install continuous road header with shuttle car in the mine
PICTOU COALFIELD							
Drummond Coal Company Limited	Drummond Westville, Nova Scotia	UG	20,985	Power generation	Rank: Mvb & Hvb "A" 1 x 7 ft seam	Mechanical dry screening, crushers cap. 75 tph	Coal deliveries to Trenton power station
Thorburn Mining Limited	Stellarton, Nova Scotia,	Reclamation project	18,137	Power generation	Coal waste dump reclamation	Water cyclones and jig cap. 100 tph	Operation started in 1974 to reclaim 3 coal mine waste dumps. Produced 5,400 tons clean coal in 1974. Capacity in 1975 is 50,000 - 60,000 tons raw coal
JOGGINS COALFIELD							
River Hebert Coal Company Limited	River Hebert Coal Mine River Hebert, Nova Scotia	UG	32,000	Power generation	Rank: Hvb "A" 1 x 36 in. seam	Mechanical dry screening cap. 50 tph	Plans for eventual phasing out of operation
NEW BRUNSWICK							
MINTO COALFIELD							
N.B. Coal Limited	Minto/Chipman areas New Brunswick	Surface	465,172	Power generation & pulp and paper companies	Rank: Hvb "A" 1 x 22 in. seam	McNally Thermal wash and dry plant cap. 150 tph	Operating at 6 locations

* Short ton (2,000 pounds) of raw coal unless otherwise noted.
** Coal Rank according to American Society of Testing Materials:
MvB - medium volatile bituminous; Hvb - high volatile bituminous;
UG - Underground.

in. - inch
ft - foot
tph - short tons per hour
tpy - short tons per year

The history of the use of Cape Breton coals in ironmaking dates back to the year 1899 when the Dominion Iron and Steel Company was formed. Since that date the fortunes of the coal industry in the Eastern Provinces have waxed and waned with the times. The growth of the mining industry hit its first peak in the 1920's. In the "boom-bust" economic cycle, production levelled off during the next decade and, with the depressed 1930's, demand for coal dropped far below the capacity of miners to produce. The outbreak of World War II heralded the greatest boom to the Eastern Canadian Coal Industry which responded with record production figures. From this all-time high there was a steady decrease in coal production which was greatly accelerated by the dieselization of the railroads which was completed in 1961. The resultant loss of this market was a serious blow to the industry that resulted in the closing of many coal mines of marginal value.

Recent efforts to revitalize the steel and coal industries of eastern Canada include the development of a new modern mine by the Cape Breton Development Corporation (Devco) to efficiently produce coals from the Harbour Seam in the Lingan area, Cape Breton county. The new mine at Lingan started its first longwall in August 1974. A second and third longwall were in operation in 1975 to raise the mine capacity to 2 million tons per year. Coal production from the new mine will help to offset recent setbacks such as the permanent closure of No. 12 Mine in 1973 due to an explosion and fire, a three month closure of No. 26 Colliery, the major producer of coking coal, and some damage to surface buildings of the old Princess Colliery. Unanticipated coal production from the Lingan mine has created optimism in the industry. Two new mines with a total annual estimated production of 2 million tons are scheduled for 1979. Planned underground expansion is predicted to increase overall production to 4 million tons per year by the end of the decade.

A new coal cleaning plant is under construction to beneficiate Cape Breton coals particularly for metallurgical purposes. The plant, which includes facilities specifically designed to lower the sulphur content, is scheduled for operation by late 1976.

Cansteel Corporation, a provincial agency, was formed in 1975 with one of its responsibilities to review and to determine the best role of Sydney Steel Corporation (Sysco) within a new integrated steel complex (proposed for Cape Gabarus) and to advise the government of Nova Scotia on the inter-relations between such a steel complex and the modernization or expansion of the facilities of Sydney Steel Corporation. The proposed new complex, at an estimated cost of 1.5 to 2 billion dollars, will ultimately produce approximately 5.5 million tons of primary iron a year which would require an estimated 4 million tons of coking coal for the production of good quality blast furnace coke. The advanced feasibility study announced by the Premier of Nova Scotia in December 1975 is well underway. If the study is successful in convincing partners and investors to develop this promising site as an integrated steel plant, the coking coals of eastern Canada will play a major role.

COKE-MAKING IN EASTERN CANADA(5,6)

The history of coke-making in Canada dates back to the nineteenth century. It probably had its inception in eastern Canada with the development of the steel industry in the province of Nova Scotia when, in 1849, a furnace and related works were built at Londonderry to utilize iron ore from the Cobequid Mountains. The extent of the deposit was not as great as anticipated and the plant was dismantled in 1908. There is no record of the source of carbon for this early operation. In 1890, the New Glasgow Iron, Coal and Railway Company (NGICR Co.) was organized to build a furnace at Ferrona in Pictou county, as well as a coal washery and coke ovens. The blast furnace, using ore from a deposit near New Glasgow, was blown-in on August 6, 1892, and was the first of its kind in Canada. The coal washing plant, also the first of its kind in North America, went into operation in May of 1892 and treated coal from Stellarton which averaged 17-25 percent ash and 2 percent sulphur. The coke ovens were the first top charged pusher-type coke ovens to be set up on this continent. The NGICR Company obtained possession of part of Wabana deposit on Bell Island, in 1894, and commenced operation at Ferrona in late 1895. On January 1, 1895, the NGICR Co. united with the Nova Scotia Steel and Forge Company under the name of Nova Scotia Steel Company. At some time during this period, the company acquired mineral rights to part of the Cape Breton coalfield and , with the excellent harbour available there and the proximity to Wabana, erected a steel plant in 1902 at Sydney Mines to replace the original Pictou works; a blast furnace was built as well as four batteries of coke ovens. Also built at the colliery was a 50-tph coal washery, comprising two sets of Luhrig jigs.

The Dominion Iron and Steel Company commenced operation at Sydney, Nova Scotia on July 1, 1899. The first coke oven battery commenced operation on November 23, 1900, and consisted of four hundred Otto-Hoffman beehive ovens. Coal was purchased from the Dominion Coal Company and cleaned in a washery comprising two Baum jigs at the Sydney Plant.

However, by 1903, the sulphur in the unwashed coal reached 2.75 percent and, with the opening of No. 6 colliery, increased to 6 percent with a corresponding high ash content. A breach of contract suit ensued and was settled in 1907 with the Dominion Iron and Steel Co. acquiring control of the coal company. This resulted in the formation of the Dominion Steel Corporation in 1910, as a holding company for both industries.

The first battery of Koppers ovens was commissioned on October 12, 1918, and the second battery in March 1919 . The old Otto-Hoffman ovens were dismantled during 1920, and a third battery of Koppers ovens was completed in November 1923 . Each of the three batteries contained 60 ovens (17-in. width). The expanded steel industry in this period carbonized about 4,000 tons of coal per day and had, at that time, the finest coke plant on the continent.

The two batteries that are still in use at the present time were put in service in 1949 (53 ovens) and 1953 (61 ovens) and are now operated by the Sydney Steel Corporation. The ovens are Koppers-Becker underjet, low-differential-type, 17-in. ovens, with a 12-ft coal line; capacity is 684 cu ft, or 17.2 tons, at 50 lb / cu ft coal bulk density.

The coking coals of eastern Canada which are available for the manufacture of coke are high volatile gas coals and pseudo gas coals by rank classification. Prime quality coals of this type have excellent coking propensity but shrink excessively upon carbonization, thus producing coke with weak strength properties. Normally excellent quality coke is obtained by blending such coals with coals of low and medium volatile matter content. Typical properties of the principal seams of coal available for coke-making are given in Table 4*.

Until recent years, coke was manufactured at the Sydney coke ovens from 100 percent high volatile coking coals available in the Cape Breton area, due to the remoteness of the plant from low volatile coal sources. As coal from the Phalen Seam has slightly better coking properties

The general philosophy of coke-making and the significance of caking and coking parameters were discussed in the companion paper on coking coals of western Canada (1).

TABLE 4

Typical Properties of Harbour and Phalen Seam Coals

	Harbour Seam		Phalen Seam	
Rank Classification				
ASTM	hvAb		hvAb	
Specific Volatile Index (7)	165		178	
Mean Reflectance* (8)	0.85		0.90	
	Clean	Raw	Clean	Raw
Grade (dry basis)				
Ash %	5	8	6	11
Vol. Matter %	37	36	34	32
Sulphur %	1.3	2.9	2.1	3.9
Phosphorus (P_2O_5) %	0.03	-	0.01	-
Alkalis (Na_2O and K_2O) %	0.08	-	0.02	-
Coking Properties				
Free Swelling Index - FSI	8	8	9	9
Plasticity (Gieseler) dd/m**	>20000	3146	6000	2700
Coking Properties				
Stability Factor of Coke	30	-	-	-
Expansion/Contraction %	- 20	-	-	-

* Values are averaged and are related to depth of mining in sampled location.

** dd/m - dial divisions per minute

than Harbour Seam coal, it was used in as high a percentage as practicable, a 60:40::Phalen:Harbour mixture being the objective. The mines chosen from these seams were those with the lowest relative sulphur and ash contents; the Phalen Seam coal in general has a higher sulphur content than the Harbour Seam coal. In 1961, it became necessary to import low volatile coal from the Appalachian coalfields in the U.S.A. to blend with the Cape Breton coals for the production of the high strength coke demanded for increased blast furnace efficiency. A blend comprising approximately 20 percent low volatile coal produced coke of excellent strength properties.

It is of interest to note that during the past year the low volatile imported coal has been replaced by low volatile coal from western Canada. The Sysco coke plant is the only conventional plant in Canada now producing coke from all-Canadian coal sources. Table 5 gives a comparison of coke quality before and after blending with low volatile coal. A further improvement in coke quality may be achieved in a three-way blend including a medium volatile coal.

Although there are no indications of the availability of low volatile coals in eastern Canada for blending pruposes, some interest has been expressed in the Pictou coalfields which contain coals of higher rank than the Cape Breton coals. Experimental coke oven tests were carried out by the Mines Branch (now CANMET) in 1951 and 1959 with coals from several seams supplied by the Intercolonial Coal Company Limited and the Acadia Coal Company Limited. The Pictou coals were blended with a blend of Harbour and Phalen Seams and carbonized in a 12-inch Koppers-type movable-wall coke oven. An improvement in the coke strength was obtained with a reduction in sulphur content but with increased ash content. It may not be possible however to increase the strength level to that required by present coke quality standards.

Recent samples of coal, obtained from the new Lingan mine (Harbour Seam) and tested by CANMET, have shown an increase in coal rank with depth of cover from 90 to 1000 feet. The coking propensity as indicated by thermal rheology properties has also indicated a progressive increase with depth of cover. It is postulated that beyond 1000 feet of cover the properties of coal from Lingan mine will be similar to those properties of coal from the old coal workings of No. 26 Colliery. The new coal washery will clean all the coal rather than part of it as has been the practice in the past. The plant should reduce the sulphur and ash contents to levels lower than previously obtained for metallurgical coal from the Harbour Seam, as well as providing a coal with more uniform coking properties.

TABLE 5

The Effect of Blending Low Volatile Coal with Harbour Seam Coal on the Quality of the Resultant Coke

		100% Harbour Seam		20% lv Coal (USA) 80% Harbour Seam		25% lv Coal (W. Canada) 75% Harbour Seam	
		*	**	*	**	*	**
Coke Strength							
Stability Factor		29	30	60	51	55	51
Hardness Factor		65	57	70	64	68	67
Coke Analysis							
Ash	%	7.2	7.6	7.4	7.8	6.5	7.8
Sulphur	%	1.1	1.1	1.0	0.7	0.9	0.7
Coke Yield	%	-	68	-	70	-	71

* Commercial coke (private communication)
** Test oven coke (CANMET)
Note: As results were obtained over a span of several years the cokes produced are not from representative coal samples.

CONCLUSION

The high volatile coals of eastern Canada have good potentials as the major component for the manufacture of good quality coke. Admixtures of low or low/medium volatile coals will be required to reduce their excessive shrinkage characteristics. New innovations to coke-making such as preheating, use of agglomerates, selective pulverization or formed coke may have additional advantages. The ash contents are quite attractive and the high sulphur content may not be as detrimental as in the past, due to improved cleaning facilities and the practice of external desulphurization of the iron.

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