REPORT OF THE

ROYAL COMMISSION ON COAL

1946

Hon. Mr. Justice W. F. Carroll, *Chairman*
Mr. Angus J. Morrison
Hon. Mr. Justice C. C. McLaurin

OTTAWA
EDMOND CLOUTIER, C.M.G., B.A., L.Ph.,
KING'S PRINTER AND CONTROLLER OF STATIONERY
1947

Rt. Hon. Clarence D. Howe, P.C., M.P.,
Minister of Reconstruction and Supply,
Ottawa.

Dear Mr. Howe:—I have the honour to transmit herewith the report of the Royal Commission on Coal pursuant to the Order of His Excellency the Governor General in Council dated October 12, 1944, P.C. 7756.

The Commission held public sittings in all the provinces of Canada. Visits were made to most of the coal fields in Canada, and to some of the fields in the United States. Complete co-operation and assistance was given to the Commission by officers of the Dominion, provincial and municipal Governments, and particularly by officers of the Department of Mines and Resources and Coal Control. We are also grateful for much valuable assistance from many organizations who submitted briefs, and from representatives of coal operators, trade unions, Canadian and American railways, chemical, petroleum and hydro-electric industries, and the coal distribution trade.

The work of the legal, secretarial, and research staff of the Commission has been of high order and we wish to express to them our appreciation. I would mention in particular the work of our secretary, Robert D. Howland, and our economist, R. W. Lawson.

Yours faithfully,
W. F. CARROLL,
Chairman.

Ottawa,
December 14, 1946.

FOREWORD

In pursuance of its terms of reference the Commission inquired into all aspects of the supply and use of coal in Canada. The result is presented in the various chapters of this report. Much of the work proved technical, but we have tried throughout to write for the benefit of those who have no specialized knowledge on these matters. Some of the chapters contain suggestions in the nature of recommendations, but the main recommendations as to a Federal coal policy are found in the final chapter.

PRIVY COUNCIL

CANADA

Certified to be a true copy of a Minute of a Meeting of the Committee of the Privy Council, approved by His Excellency the Governor General on the 12th October, 1944.

The Committee of the Privy Council have had before them a report, dated October 3, 1944, from the Minister of Munitions and Supply, representing that in his opinion it is expedient in the public interest that a full inquiry be made into the coal industry in Canada.

The Committee, therefore, on the recommendation of the Minister of Munitions and Supply, advise,—

1. That the Honourable Mr. Justice W. F. Carroll of the City of Halifax, in the Province of Nova Scotia, Mr. Angus J. Morrison of the City of Calgary, in the Province of Alberta, and the Honourable Mr. Justice C. C. McLaurin of the City of Calgary in the Province of Alberta, be appointed Commissioners under Part I of the Inquiries Act, Chapter 99 of the Revised Statutes of Canada, 1927, to inquire into and report upon the problems of and matters pertaining to the coal industry in Canada, having regard, generally, to pre-war, present and anticipated post war conditions and the probable future development of Canada;

2. That the Commissioners be authorized to have, exercise and enjoy all the powers conferred upon them by Section 11 of the said Inquiries Act, and that any person deputed by the Commissioners to inquire into any matter within the scope of the Commission, as may be directed by the Commissioners, be authorized to have and exercise the same powers which the Commissioners have, to take evidence, issue subpoenas, force the attendance of witnesses, compel them to give evidence and otherwise conduct the inquiry;

3. That the Honourable Mr. Justice W. F. Carroll be Chairman of the Commissioners;

4. That the Commissioners make their report and recommendations with the least possible delay; and

5. That the Departments of the Government Service of Canada afford the Commissioners and all persons acting under their authority or by their direction, such assistance and co-operation in the matters of the inquiry as the Commissioners may think desirable.

"A. D. P. HEENEY,"
Clerk of the Privy Council

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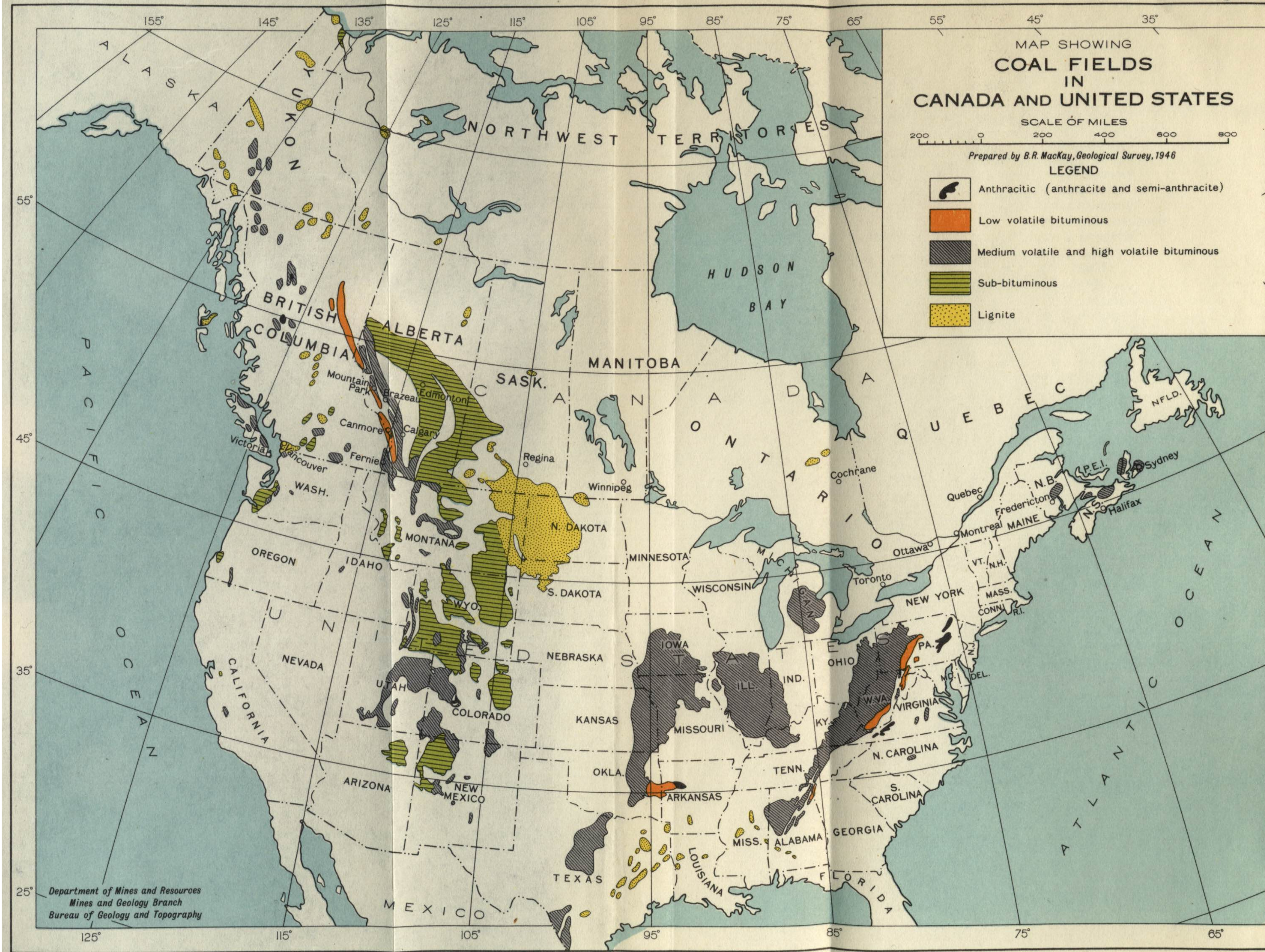
MAP SHOWING
COAL FIELDS
IN
CANADA AND UNITED STATES
SCALE OF MILES
200 0 200 400 600 800
Prepared by B.R. MacKay, Geological Survey, 1946
LEGEND
Anthracitic (anthracite and semi-anthracite)
Low volatile bituminous
Medium volatile and high volatile bituminous
Sub-bituminous
Lignite
Department of Mines and Resources
Mines and Geology Branch
Bureau of Geology and Topography
ALASKA
YUKON
NORTHWEST TERRITORIES
HUDSON BAY
BRITISH COLUMBIA
ALBERTA
SASK.
MANITOBA
ONTARIO
QUEBEC
CANADA
NFLD.
P.E.I.
N.B.
N.S.
PACIFIC OCEAN
ATLANTIC OCEAN
UNITED STATES
MEXICO
Mountain Park
Brazeau
Edmonton
Canmore
Calgary
Fernie
Victoria
Vancouver
Regina
Winnipeg
Cochrane
Quebec
Fredericton
Sydney
Halifax
Montreal
Ottawa
Toronto
WASH.
OREGON
IDAHO
MONTANA
N. DAKOTA
S. DAKOTA
MINNESOTA
WISCONSIN
MICHIGAN
WYO.
NEVADA
CALIFORNIA
UTAH
COLORADO
NEBRASKA
IOWA
ILL.
IND.
OHIO
PA.
NEW YORK
MAINE
VT.
N.H.
MASS.
CONN.
R.I.
N.J.
DEL.
MD.
W.VA.
VIRGINIA
KY.
KANSAS
MISSOURI
OKLA.
ARKANSAS
TENN.
N. CAROLINA
S. CAROLINA
GEORGIA
ALABAMA
MISS.
LOUISIANA
TEXAS
FLORIDA
ARIZONA
NEW MEXICO
155° 145° 135° 125° 115° 105° 95° 85° 75° 65° 55° 45° 35°
55° 45° 35° 25°
125° 115° 105° 95° 85° 75° 65°

CHAPTER I

COAL RESERVES

This chapter is divided into three sections. The first section deals in general terms with the origin and classification of coals and the relation of the various characteristics of coals to their use. In the second section previous estimates of Canadian coal reserves and the basis of the estimate prepared for this Commission are discussed. Canadian reserves are then reviewed from a national point of view followed by more detailed description and discussion of the provincial coal fields. The final section deals with some aspects of the world supply of coal with particular reference to the coal reserves of countries which normally supply the Canadian market.

ORIGIN AND CLASSIFICATION OF COAL

Origin of Coal

Coal may be defined as plant or vegetal matter which, after millions of years of burial and through the action of chemical agencies and heat and pressure, has been converted into a compact mineral fuel. More specifically, the cellulose, lignin and resin constituents, the principal contents of the original vegetal matter, have been subjected to a number of chemical and physical changes involving a loss of moisture and volatile constituents composed of oxygen, hydrogen and carbon, some re-arrangement in the molecules of the remaining constituents and an increase in the proportion of fixed carbon and ash. The maturity of a coal is related to the degree it has undergone these processes, the more highly developed coals having less moisture and volatile constituents and a higher percentage of fixed carbon than the less mature coals. The ash of a coal is mineral matter which comes partly from the plants themselves and partly from the sediment carried by wind or water into the swampy basins where the plant and forest vegetation grew or accumulated before being buried to form a coal seam. Thus, the ash content of a coal is largely accidental and has no relation to maturity except in so far as the loss of moisture and volatile constituents increases the proportion of the ash to the total of the coal constituents. Coal then consists essentially of moisture, fixed carbon, volatile matter and ash but the proportions of these constituents vary according to its state of development. Any considerable differences in the vegetal matter from which the coal substance was formed or in the sediment from which its ash content is derived are reflected in the chemical and physical properties of a coal. As coal deposits have been formed in widely separated areas and under a variety of conditions, coals differ widely in characteristics. This diversity of characteristics has necessitated standardized analyses and classification of coals.

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Classification of Coal

It is probably true to say that there are as many ways of classifying coal as there are uses to which it is put. Until recently, no uniform standards of analysis and classification existed even on the North American Continent; for example, coals having substantially the same physical and chemical composition and heat value were designated differently in Canada and the United States. Difficulties arising from this divergence in classification, especially apparent in applying tariff regulations governing the importation and exportation of coal between the two countries, emphasized the long felt necessity for the development of a uniform and scientific classification of coals on the American Continent. In 1928 the National Research Council set up an "Associate Committee on Coal Classification and Analysis". The Committee was composed of representatives of the Federal Department of Mines and provincial authorities, and professional and industrial specialists. Work was carried on in close association with an earlier formed sub-committee of the American Society for Testing Materials and the American Standards Association, which was concerned with the same problem. After nearly ten years of united effort, a uniform system of classification was evolved and was later approved by both the American and Canadian Committees. Full particulars of this system appear in a report on "The A.S.T.M. Standard Specifications for Classification of Coals by Rank and by Grade and their Application to Canadian Coals" issued by the National Research Council in June, 1939, as N.R.C. No. 814. Under the A.S.T.M. system, coals are classified by standard tests and analyses according to Rank, Grade, Type and Use.

Rank classification, broadly speaking, identifies the degree of maturity of coals or the extent to which they have progressed in the process of alteration from the original vegetal matter, the different classes and groups indicating the various stages of metamorphism through the series peat, lignite, sub-bituminous, bituminous and anthracite. It is essentially a scientific classification based on the chemical properties of the coals and is considered fundamental as other classifications can be based on it. Rank classification is based on the fixed carbon percentage and the calorific value of the coal calculated on a mineral-matter-free basis (ash free). The higher rank coals are classified according to the percentage of fixed carbon on a dry basis whereas the lower rank coals (containing less than 69 per cent fixed carbon) are classified according to B.t.u. per pound on the moist (as mined) basis. When lower rank coals are marginal between bituminous and sub-bituminous, those which will withstand exposure to air without crumbling or slacking (non-weathering coals) and/or tend to cake (agglomerate) on burning are automatically raised in classification to the bituminous rank. Higher rank coals, marginal between bituminous and semi-anthracite, are delimited according to their agglomerating properties. Coals having the other properties of semi-anthracite but showing agglomerating properties are lowered in classification to low volatile coal, the highest group of the bituminous class. The four classes and thirteen groups and their delimiting factors according to the A.S.T.M. system of classification by rank are indicated in the following table.

CLASSIFICATION OF COALS BY RANK

(A.S.T.M. Designation: D.388—38)—1937

Class	Group	Limits of Fixed Carbon or B.t.u., Mineral-Matter-Free Basis	Requisite Physical Properties
I. Anthracite	1. Meta-anthracite	Dry F.C., 98 per cent or more.	
	2. Anthracite	Dry F.C., 92 per cent or more and less than 98 per cent.	
	3. Semi-anthracite	Dry F.C., 86 per cent or more and less than 92 per cent.	Non-agglomerating[1].
II. Bituminous[3]	1. Low volatile bituminous coal.	Dry F.C., 78 per cent or more and less than 86 per cent.	
	2. Medium volatile bituminous coal.	Dry F.C., 69 per cent or more and less than 78 per cent.	
	3. High volatile A bituminous coal.	Dry F.C., less than 69 per cent and moist[2] B.t.u. 14,000[4] or more.	
	4. High volatile B bituminous coal.	Moist[2] B.t.u. 13,000 or more and less than 14,000.	
	5. High volatile C bituminous coal.	Moist B.t.u. 11,000 or more and less than 13,000[4].	Either agglomerating or non-weathering[5].
III. Sub-bituminous	1. Sub-bituminous A coal.	Moist B.t.u. 11,000 or more and less than 13,000[4].	Both weathering and non-agglomerating[5].
	2. Sub-bituminous B coal.	Moist B.t.u. 9,500 or more and less than 11,000[4].	
	3. Sub-bituminous C coal.	Moist B.t.u. 8,300 or more and less than 9,500[4].	
IV. Lignitic	1. Lignite	Moist B.t.u. less than 8,300.	Consolidated.
	2. Brown coal	Moist B.t.u. less than 8,300.	Unconsolidated.

[1]If agglomerating, classify in low-volatile group of the bituminous class.
[2]Moist B.t.u. refers to coal containing its natural bed moisture but not including visible water on the surface of the coal.
[3]It is recognized that there may be non-caking varieties in each group of the bituminous class.
[4]Coals having 69 per cent or more fixed carbon on the dry, mineral-matter-free basis shall be classified according to fixed carbon, regardless of B.t.u.
[5]There are three varieties of coal in the high-volatile C bituminous coal group, namely, Variety 1, agglomerating and non-weathering; Variety 2, agglomerating and weathering; Variety 3, non-agglomerating and non-weathering.

Grade classification is devised to indicate, from a commercial standpoint, the principal properties of a coal as marketed. It covers calorific value, amount and nature of the ash, sulphur content and size. No name is attached to any grade so that this form of classification may be said to provide a single and uniform system by which the coal operator or dealer may specify the coal tendered. As compared with rank classification, the emphasis of grade classification is on the nature and amount of the ash content of the coal. Thus, the analyses in this instance are expressed on the basis of coal as sampled or received rather than adjusted to the mineral-matter-free basis as in the first instance. The calorific value of any coal on the "as received" basis obviously will be lower than when adjusted to either the "mineral-free" or "dry mineral-free" basis employed in rank classification, and it is important to be assured that calorific value analyses of different coals are calculated on a similar basis when making comparisons. It should be noted perhaps at this point that the grade of a coal can be, and often is, improved by preparation for the market. Beneficiation, on the other hand, will not affect the rank of a coal. The tables which follow show the symbols for grading coal according to ash, softening temperature of ash and sulphur, as per A.S.T.M. standard specifications, and the symbols for size designation, as tentatively specified by the Canadian Government Purchasing Standards Committee.

SYMBOLS FOR GRADING COAL ACCORDING TO ASH, SOFTENING TEMPERATURE OF ASH, AND SULPHUR (ANALYSIS EXPRESSED ON BASIS OF THE COAL AS SAMPLED).

(A.S.T.M. Designation: D.389—37)—1937.

Ash[1]		Softening Temperature of Ash[2]		Sulphur[1]	
Symbol	Per cent[3] inclusive	Symbol	°F. inclusive	Symbol	Per cent inclusive
A 4	0.0 to 4.0	F28	2800 and higher	S0.7	0.0 to 0.7
A 6	4.1 to 6.0	F26	2600 to 2790	S1.0	0.8 to 1.0
A 8	6.1 to 8.0	F24	2400 to 2590	S1.3	1.1 to 1.3
A10	8.1 to 10.0	F22	2200 to 2390	S1.6	1.4 to 1.6
A12	10.1 to 12.0	F20	2000 to 2190	S2.0	1.7 to 2.0
A14	12.1 to 14.0	F20—	Less than 2000	S3.0	2.1 to 3.0
A16	14.1 to 16.0	....	....	S5.0	3.1 to 5.0
A18	16.1 to 18.0	....	....	S5.0+	5.1 and higher
A20	18.1 to 20.0	....	....	....	....
A20+	20.1 and higher	....	....	....	....

[1] Ash and sulphur are reported to the nearest 0.1 per cent by dropping the second decimal figure when it is 0.01 to 0.04 inclusive, and by increasing the percentage by 0.1 per cent when the second decimal figure is 0.05 to 0.09 inclusive. For example, 4.85 to 4.94 per cent, inclusive, is considered to be 4.9 per cent.

[2] Ash-softening temperatures are reported to the nearest 10 F°. For example, 2635 to 2644° F. inclusive, is considered to be 2640° F.

[3] For numerical grading of coals, ranges in the percentage of ash smaller than 2 per cent are commonly used.

SYMBOLS OF SIZE DESIGNATIONS AND CUSTOMARY TRADE TERMS

(Specification for Coal No. 18-GP-1-1940 Canadian Government Purchasing Standards Committee)

Size Designation	Size Limits (round-hole screens)[1]	Customary Trade Designation[2]
A	Retained on ⅛ inch screen[3]................................	Run-of-mine or dock-run
B	Retained on 1½ inch screen[3]................................	Lump
C	Passing 3 inch, retained on 2½ inch screen[4]..................	Egg
D	Passing 2½ inch, retained on 1½ inch screen[4]..................	Stove
E	Passing 2 inch, retained on 1/16 inch screen..................	Nut slack
F	Passing ¾ inch, retained on 1/32 inch screen..................	Slack
G	Passing 1½inch, retained on ¾ inch screen.....................	Stoker nut
H	Passing ¾ inch, retained on ⅜ inch screen.....................	Stoker pea
J	Passing 9/16 inch, retained on 5/16 inch screen...............	Buckwheat No. 1 (blower)
K	Passing 5/16 inch, retained on 3/16 inch screen...............	Buckwheat No. 2 (blower)
L	Passing 3/16 inch, retained on 3/32 inch screen...............	Buckwheat No. 3 (blower)

[1] Not more than 15 per cent by weight of the sample may pass the screen defining the lower size limit and not less than 95 per cent may pass that defining the upper size limit.

[2] Owing to variations in trade designations this column is given as a convenience only: the alphabetical designation given in the left-hand column governs.

[3] The purchaser may specify a maximum permissible size, in which case not less than 95 per cent of the coal shall pass the screen indicated.

[4] The purchaser may specify another maximum permissible size, in which case not less than 95 per cent of the coal shall pass the screen indicated.

Type classification emphasizes the geological approach in the analysis of coals, and relates particularly to the segregation of coals according to the nature of the material from which the coal was originally formed. It separates such coals as Splint, Cannel and Boghead coals which are thought to have been formed principally of aquatic organisms, both plant and animal, from the ordinary coals formed from terrestrial plant life. These factors affect the characteristics of coals, and when further advanced, this method of classification may have important practical application. At the present time, type classification has little practical importance.

As suggested in the title, classification by use seeks to relate other forms of classification to the actual use of coal for specific purposes. It should be noted, however, that those concerned with the preparation of A.S.T.M. specifications were unable to agree on definite standards after some years of careful study. Their efforts were frustrated by the many variants which entered into the calculation relating not only to the wide variation of coals but also to the diversity of existing combustion and other equipment and the overwhelming importance in many instances of cost factors. Price differentials may allow a coal of a lower grade and less appropriate rank to be used perhaps with lower efficiency but still at an economic advantage to the user in place of a more desirable but more expensive coal.

Certain properties of coals are of fundamental importance in the consideration of the commercial value of coal. Some of these are related to its rank or grade but others are not. Some indication of these properties at this time will be useful to our general purpose of discussing coal reserves and may serve as background for later consideration of the question of coal marketing and utilization.

1. *Calorific Value.*—For practical purposes, one of the most important properties of a coal is its calorific value, which may be defined as the amount of heat developed by the combustion of a unit weight of the coal. It is usually expressed in terms of B.t.u./pound. As previously suggested, the calorific value of a coal is calculated on an as received basis when measured for the purposes of grade classification, and adjusted for ash and moisture in respect to rank classification. Generally speaking, the higher rank coals have a higher calorific value. In practice, a high percentage of fixed carbon and low percentage of ash and moisture results in a high calorific value. It should be noted perhaps that when calculated on the dry mineral-free basis, coals above the rank of low volatile bituminous tend to decline in calorific value indicating that the maximum heat value of a coal results where the fixed carbon and volatile matter are most effectively balanced rather than in those coals having the highest percentage of fixed carbon.

2. *Ash Content and Fusibility.*—The ash content of a coal is important from the point of view of both the amount of ash and its nature. High ash content means reduced calorific value per unit weight of coal, and thus will be important not only in operation but also in the economics of long distance transportation. In addition, ash handling is important to the consumer from the point of view of inconvenience and possibly of cost. With suitable combustion equipment, a comparatively high ash content may not seriously affect the thermal efficiency of utilization. It should be noted perhaps that coals with a very low ash content may fail to give the required protection to grates normally provided by ash. The importance of the nature of the ash relates particularly to the temperature at which the ash tends to fuse or clinker. Coals are said to have a high, medium or low fusion point of ash according to whether the ash fuses within the following ranges:

Low fusion point of ash	Below 2200° F.
Medium fusion point of ash	2200° F. to 2600° F.
High fusion point of ash	Above 2600° F.

Unless suitable combustion equipment has been installed, a coal with a low fusion point of ash cannot be used for steam raising purposes where high boiler temperatures are required. On the other hand, a certain degree of clinkering is desirable in coals used in domestic underfeed stokers and in this instance a low fusion point of ash may be a positive factor in the selection of a coal.

3. *Volatile Matter.*—The volatile matter is the portion of the coal other than moisture that is driven off as gas or vapour when heated. For some purposes, it is desirable to select coals having a low proportion of volatile matter, especially where the coal is to be used in hand-fired equipment with natural draft or for blacksmithing as the low volatile coals burn more steadily and are less smoky. On the other hand, in the manufacture of gas in vertical retorts certain high volatile coals command a premium as they produce a maximum proportion of gas.

4. *Sulphur Content.*—The sulphur of coal is usually distributed between the organic (pure coal) material and the ash. For general purposes, the quantity of sulphur present in the coal, unless it is very high, has limited practical importance. However, in the production of manufactured gas and metallurgical coke, the sulphur content becomes of primary significance. Rigid restrictions are imposed on the permissible sulphur contents of gas distributed by commercial gas companies while in metallurgy sulphur has a harmful effect unless eliminated and this is a costly process.

5. *Coking.*—The terms coking and caking are sometimes used synonymously in technical literature relating to coal. Efforts are now being made to distinguish the terms and confine the use of the term "coking" to coals which can be employed in the manufacture of coke for metallurgical or domestic purposes. Caking is an overall term and refers to the tendency of coals to coalesce and form either a cake or a coke-like structure when heated, whereas coking is confined to coals which form a cellular coke-like structure when heated. The requisite properties of a coal which determine its suitability for use in the manufacture of coke are discussed in the chapter on Products and By-Products where the coke and gas industry is reviewed. It is sufficient at this time to indicate that coking properties relate closely to rank and grade.

6. *Structure.*—The structure of a coal has importance from several points of view. As suggested in rank classification, certain coals of the lower ranks tend to crumble or slack when exposed to the air. Non-weathering properties of a coal affect its storage and transportation as such coals will disintegrate if transported or stored exposed to the weather. Such coals are also liable to spontaneous combustion when stored in any quantity. Many coals also crumble or slack when handled, in which case they are said to be friable. Friability, however, unlike weathering characteristics, has little direct relation to rank. It is more related to the geology of the coal and the conditions under which the coal matured. This factor of friability is important in both mining and marketing as coals which are friable cannot be readily extracted in domestic sizes while larger sized coals tend to break down when transhipped (degradation). The structure of a coal is also of importance in respect to crushing and pulverizing coals for various uses. When coal is pulverized before use, its resistance to pulverization (grindability) becomes an important factor in coal selection as the cost and ease of grinding will vary according to the grindability index of the coal.

7. *Burning Characteristics.*—The burning characteristics of coals vary with the coal and the combustion equipment utilized, and for this reason few objective standards have been established. Although no sharp boundaries can be drawn between the burning characteristics of the different ranks of coals, some generalizations can be made. Thus it can be said that anthracite commands a premium when burned in hand-fired equipment with natural draft because whereas it ignites slowly, it burns continuously with a minimum of attention and is a clean almost smokeless fuel. The bituminous coals, as the volatile matter increases, tend to produce soot and smoke when burned in this type of equipment because the hydro carbons in the volatile matter do not burn freely. Increased combustion space and different methods of firing are essential to ensure satisfactory combustion of such coals. The sub-bituminous and lignite coals produce little or no smoke as the volatile matter contains more oxygen thus facilitating combustion. Increased combustion space is also necessary in this instance as additional fuel must be burned owing to the low heat value of these coals. In respect to automatic equipment with forced draft, these burning characteristics are less important as they are then more subject to control. Cost factors and the other properties of the coal such as fusion point of ash then assume increasing importance although rigid smoke regulations may still place a premium on what are called smokeless coals.

The inter-relation of many properties of a coal in its commercial evaluation is forcefully illustrated in the selection of coals for railway locomotive purposes. Dealing with the matter of price differentials between various coals, a representative of the Canadian National Railways stated to the Commission;

"There is, of course, some objection to fixing differentials solely on a calorific basis since these figures alone do not necessarily determine the performance of a particular coal on locomotives and its actual value to the Railway. Size and structure of the coal, and fusion point of the ash are also important. Some coals will perform satisfactorily on short runs, but, because of clinkering characteristics, etc., are unsatisfactory for long runs. Other coals are so fine in structure that stack losses are excessive, and more coal is consumed than would be indicated by the analysis of the coal. The C.N.R. could not, therefore, agree to calorific value alone as necessarily being a sound basis of comparison for the purchase of its coal; on which account running tests are made from time to time to determine the value of the various coals in actual service."

In view of the importance of these various characteristics of coal, a number of standard chemical analyses and physical tests have been developed on the basis of which coals are classified in a number of ways. The usual analysis applied is what is known as the proximate analysis. This comprises determinations for moisture, ash and volatile matter contents with the fixed carbon percentage obtained by the difference. Such an analysis does not include the components of the volatile matter or the ash, the fusion point of ash, calorific value, physical characteristics such as its coking, friability, grindability, weathering or slacking properties. Determinations of the carbon, hydrogen, nitrogen and oxygen elements in the coal and sulphur content are made in what is known as the ultimate analysis while specific tests are performed to cover the other characteristics. In practice, the determinations of the proximate analysis are sufficient for day-to-day commercial transactions as coals in any field do not vary to any great extent in respect to the characteristics determined by the more complete analyses, and once these have been established, there is no great necessity to repeat the tests at short intervals. It is customary in giving general information as to coals to quote what is commonly called a typical analysis which includes the results of the proximate analysis and sulphur, fusion point of ash and calorific value determinations. It would appear as follows for, say, coals of the Cascade area, Alberta:

	(As received basis)	
Moisture	Per cent	1.5
Volatile Matter	Per cent	12.8
Fixed Carbon	Per cent	77.5
Ash	Per cent	8.2
Sulphur	Per cent	0.7
Calorific Value	B.t.u./lb.	13,910
F.P.A.	°F.	2850+

It is evident that the Fuels Division of the Federal Department of Mines and Resources and various provincial authorities have contributed effectively to the development of standard tests and analyses of coal and we note with pleasure that their American colleagues have been most generous in their appreciation of the contribution of Canadian scientists to the development of the A.S.T.M. standard specifications. Very considerable application of these tests has been made by these organizations with the result that valuable data are now available concerning the physical and chemical characteristics of Canadian coals.

CANADIAN COAL RESERVES

The location of Canada's coal deposits is shown on Map 1 which prefaces this chapter. Some particulars of the geology of the various Canadian coal deposits are given in later pages when reserves are discussed by provinces.

Very complete data are available concerning most of the coal fields in reports published by the Federal Department of Mines and Resources. The provincial authorities have also published some very instructive reports on a number of fields.

In succeeding pages and throughout the report, Canadian coals are classified by rank according to the A.S.T.M. specifications. It should be noted that reports from the Dominion Bureau of Statistics have retained the old classification. As a result, some discrepancies may appear between the statistics used by this Commission and those published by the Dominion Bureau. For example, coals reported by the Dominion Bureau as lignites are referred to by the Commission as sub-bituminous coals, the rank they achieve under the A.S.T.M. classification. The Commission understands that the Dominion Bureau of Statistics is adopting the A.S.T.M. classification. We think that this step is commendable.

ESTIMATES OF RESERVES

The most widely known and, in fact, the only Canadian-wide estimates of coal reserves in Canada available for the Commission were those prepared by Dr. Dowling in 1913. With Dowling playing a leading role, the International Geological Congress which met in Canada that year made an ambitious attempt to correlate information as to the location and extent of the coal resources of the world. At that time it was estimated that Canada's reserves of coal, including seams one foot and over to the depth of 4,000 feet, and including all ranks of coal, were 1,216,770,310,000 metric tons (2,205 pounds per ton). This figure included what Dowling termed "actual reserves" (those calculated on the basis of actual thickness and extent of seams) and "probable reserves" (including coal where an approximate estimate only could be given). Further details of this estimate appear in the following table.

SUMMARY TABLE OF DOWLING'S ESTIMATES OF COAL RESERVES INCLUDING SEAMS ONE FOOT AND OVER TO DEPTH OF 4,000 FEET, IN THOUSANDS OF METRIC TONS (2,205 LBS. PER TON)

Province	Rank of Coal	Actual Reserves	Probable Reserves	Total by Rank	Total, All Ranks
Nova Scotia	Bituminous	2,188,151	4,891,817	7,079,968	7,079,968
New Brunswick	Bituminous		151,000	151,000	151,000
Ontario	Lignite		25,000	25,000	25,000
Manitoba	Lignite		160,000	160,000	160,000
Saskatchewan	Lignite	2,412,000	57,400,000	59,812,000	59,812,000
Alberta	Lignite	382,500,000	491,271,000	873,771,000	
	Bituminous	3,223,800	182,183,600	185,407,400	
	Anthracite	669,000	100,000	769,000	1,059,947,400
British Columbia	Lignite	60,000	5,136,000	5,196,000	
	Bituminous	23,771,242	44,907,700	68,678,942	73,874,942
Yukon	Lignite		4,690,000	4,690,000	
	Bituminous		250,000	250,000	4,940,000
Northwest Territories	Lignite		4,800,000	4,800 000	4,800,000
Arctic Islands	Bituminous		6,000,000	6,000,000	6,000,000
Totals		414,804,193*	801,966,117	1,216,770,310*	1,216,770,310*

* In these totals 20,000,000 metric tons has been deducted for the amount of coal of all classes already extracted in Alberta.

In his estimate, Dowling included a total of 26,219.21 square miles for his calculation of actual reserves and 82,662.5 square miles covering probable reserves. It should perhaps be noted that, in addition to this estimate, Dowling gave figures on coal reserves, including seams of two feet and over at depths between 4,000 and 6,000 feet. This added a further 17,499,000,000 metric tons to those previously quoted and covered an additional 287 square miles.

Dowling's estimate cannot be taken as a basis of discussion of Canadian coal reserves. Subsequent geological surveys, drilling programs and the exploration of various coal fields by actual mining operations have disproven a number of his assumptions in regard to the areal extent of the fields and the continuity of seams. From this point of view alone, his estimates would have to be scaled down very considerably. At the same time it is readily apparent that Dr. Dowling's estimates, as he himself realized, were not confined to reserves of what might be termed "mineable coal." If corrected according to the latest geological information, Dowling's estimate might be considered a reasonable approximation of coal occurring as a geological phenomenon in Canada. Under no circumstances could his estimate be considered as an approximation of reserves of coal which, assuming present mining techniques, are physically available without exceptional engineering problems and prohibitive mining costs.

During the course of the Commission's enquiry, considerable evidence as to coal reserves was received. This came principally from the provincial authorities and the coal operators' associations. In addition, the principal operators were asked to provide estimates of coal reserves covering the coal lands which they held. Subsequently these data were submitted to Dr. B. R. MacKay of the Federal Department of Mines and Resources for review.

On the basis of these data and the very considerable information at his disposal at the Geological Survey, Dr. MacKay prepared for the Commission an estimate of Canadian coal reserves. In the course of this work, geological maps covering all the important coal areas in Canada were prepared, including those which appear in this report. As an example of the detailed work undertaken for this estimate, twelve maps (each relating to a single coal seam) of the Sydney coal field in Nova Scotia and fifty maps of Alberta were prepared. Hand-prepared copies of these maps are available for a small charge from the Geological Survey, but we are of the opinion that these maps should be published in an appropriate form by the Department of Mines and Resources as soon as possible.

It is readily apparent that estimates of coal reserves will depend very largely on the yardstick which is employed. From a practical point of view, the yardstick applied by Dowling is valueless. In the past, no coal one foot thick has been mined in Canada below a depth of five hundred feet, and it is extremely unlikely that it will be within the next few decades. This completely invalidates estimates based on coal seams one foot thick and over to the depth of 4,000 feet. It was most apparent from the evidence that a variety of yardsticks had been applied by the various provincial authorities and the operators in measuring the coal reserves of the various fields in Canada and that this was the result of varying mining conditions and economic circumstances in the different areas. What appeared to be an inconsistency was usually in fact a reflection of a highly practical approach, for many factors enter into the determination of what might be termed mineable coal and these will often vary in different parts of the country. For example, the quality of the coal which is mined and the price which the coal can command in the market will determine, to some extent, its mineability. Mining methods and the technical problems of extracting the coal, with particular reference to cost factors, will also be a determinant, as will be accessibility to transportation facilities. These factors are not consistent, and thus it is not desirable to apply a common yardstick to the vastly separated coal areas of Canada with their varieties of coals and mining and marketing conditions.

In order to make the Commission estimate as practical as possible, different yardsticks have been applied in various areas across Canada. These mostly conform to mining practices in the various areas in respect to minimum thickness of seam and maximum depth of cover. Some variation is also made in regard to the yardstick applied to different ranks of coal. For Nova Scotia, the estimate includes only coal of a minimum thickness of 3 feet with not more than 4,000 feet of cover except in the Joggins area where seams of average thickness of 2 feet are estimated. For New Brunswick, coal seams averaging 18 inches or more in thickness with not more than 500 feet of cover are included. The estimates for Ontario, Manitoba and Saskatchewan lignites include seams not less than 3 feet to a maximum depth of 500 feet. Alberta sub-bituminous coals are estimated on the basis of seams 3 feet or more in thickness with not more than 1,000 feet of cover. The estimates of Alberta and British Columbia bituminous coals include seams not less than 3 feet in thickness with a maximum depth of cover of 2,500 feet. The estimated reserves of British Columbia lignites and sub-bituminous coals and of the Yukon and Northwest Territories are on the basis of seams not less than 3 feet with a maximum depth of cover of 1,000 feet.

In most instances estimates of coal reserves relate to what might be termed "mineable" or "available" coal—that is, the estimate refers to coal which is considered to exist in mineable thicknesses within a required distance from the surface. However, it is unusual to recover even approximately 100 per cent of this coal. The degree of extraction varies greatly according to local conditions, both in respect to mining and market conditions. In any one operation recovery may be as high as 90 per cent, whereas in others it is as low as 20 per cent. In respect to larger areas, however, such as those included in the Commission estimate, the extent of recovery appears to be seldom more than 50 per cent. In the Commission estimate a distinction is made between "mineable" coal and "recoverable" coal, or coal which will likely be brought to the surface. The assumed extraction is 50 per cent.

Further terms are used, namely, "probable" reserves and "possible" reserves. Probable reserves include coal which by direct mining experience and by drilling, continuity to existing workings and areas drilled, or extensive geological data, can be reasonably expected to exist. Possible reserves are additional to probable reserves and include coal, the reasonable existence of which is based on limited geological data and prospecting and coal, the recovery of which is problematical due to its inferior quality and/or its relative inaccessibility. A specific gravity of coal of 1.29 has been taken as the conversion factor in calculating the reserves of the different provinces. On this basis, coal reserves are calculated at 80 pounds per cubic foot; 1,750 short tons per acre foot; or 1,120,000 short tons per square mile foot. Estimates of reserves are given throughout in short tons. The analyses are provided by the Division of Fuels of the Dominion Department of Mines and Resources and are on an "as received" basis.

Precise determinations of mineable and recoverable coal are possible only when relatively small areas are considered, when these have been extensively drilled and the deposits at least partially developed, and when local conditions are fully considered. Any overall survey of Canadian coal reserves must of necessity include coal reserves which have not been extensively drilled or developed, and must cover a diversity of mining and marketing conditions. In many instances, therefore, estimates cannot be more than mere approximations. Dr. MacKay has advised the Commission that the estimates are, in most instances, on the conservative side. The number of square miles used for purposes of calculation, with particular reference to the Provinces of Alberta and Saskatchewan, represent a very small percentage of the areas which are considered to be coal-bearing. This practice takes into full account the lack of continuity of the seams and the inconsistency of the coal formations and allows for extensive erosion which is known to have taken place in certain areas. It is likely that greater knowledge of Canadian reserves will extend rather than contract the present estimates.

The table below provides in summary form the estimated coal reserves of Canada. Some 24 tables, giving particulars of the overall figures appearing below, appear in Appendix A.

Province	Mineable Coal			Recoverable Coal		
	Probable	Possible (additional)	Total	Probable	Possible (additional)	Total
	Thousands of net tons					
Nova Scotia	1,967,024	1,147,382	3,114,406	983,512	573,691	1,557,203
New Brunswick	89,814	11,566	101,380	44,907	5,783	50,690
Ontario	100,000	50,000	150,000	50,000	25,000	75,000
Manitoba	33,600	67,200	100,800	16,800	33,600	50,400
Saskatchewan	13,126,880	11,004,000	24,130,880	6,563,440	5,502,000	12,065,440
Alberta	34,437,630	13,436,560	47,874,300	17,218,870	6,718,280	23,937,150
British Columbia	11,795,480	7,034,556	18,830,036	5,897,740	3,517,278	9,415,018
Yukon	434,560	1,449,840	1,884,400	217,280	724,920	942,200
Northwest Territories	140,000	2,489,760	2,629,760	70,000	1,244,880	1,314,880
CANADA	62,000,000	37,000,000	99,000,000	31,000,000	18,000,000	49,000,000

It will be seen from the foregoing table that Canada is estimated to possess about 99,000 million tons of mineable coal or some 49,000 million tons of recoverable coal. Approximately 63 per cent of this tonnage is classified as probable. These figures are less than 10 per cent of the 1913 estimate. However, on the basis of the current level of production of coal in Canada, the reserves would be sufficient to allow for continued mining for over 2,700 years. It is apparent, therefore, that apart from local situations the chief interest in reserves lies in the location and characteristics of the deposits.

Alberta, according to the estimate, has some 48 per cent of Canada's reserves; with Saskatchewan possessing about 24 per cent; British Columbia, some 19 per cent; the Yukon and Northwest Territories, nearly 5 per cent; Nova Scotia, a little over 3 per cent; and the other three provinces having, in aggregate, about one-third of 1 per cent. Three western provinces, Saskatchewan, Alberta and British Columbia, have 92 per cent of the total reserves. Thus an estimate of Canadian reserves on the basis of mineable coal has the effect not only of drastically reducing the 1913 estimate but of changing the relative standing of the provinces. Alberta, in this present estimate, retains a leading position but is now credited with 48 per cent rather than 85 per cent of the total reserves. Saskatchewan replaces British Columbia as possessing the second largest reserves; and whereas Nova Scotia retains fourth place, its reserves form a greater percentage of the total.

Table 2 appearing in Appendix A gives a breakdown of the reserves shown in the above table according to the rank of the coals. From this table, it will be noted that approximately 15 per cent of the total reserves are of low volatile bituminous rank; some 31 per cent are of medium volatile rank; some 17 per cent, of high volatile bituminous rank; some 9 per cent, of sub-bituminous rank; and about 28 per cent, of lignitic rank. The low volatile bituminous coals are largely concentrated in the Inner Foothills belt of Alberta and the Peace River fields of northeastern British Columbia. The medium volatile coals occur largely in the Inner Foothills belt of Alberta and in the coal fields of southeastern and north central British Columbia. The high volatile bituminous coals are much more widely distributed, occurring both in the Maritime Provinces and in British Columbia, on Vancouver Island and in the south central area. A large percentage of the tonnage, however, is concentrated in the Outer Foothills belt of Alberta. The sub-bituminous coals are largely confined to the Plains regions of Alberta. The lignite coals are widely distributed, occurring in Ontario and all the western provinces, but the principal mineable reserves are found in Saskatchewan.

This breakdown of coal reserves by rank does not indicate the reserves of coking coals. This aspect of reserves is reviewed in later discussion of the coke and gas industry appearing in the chapter on Products and By-Products.

PROVINCE OF NOVA SCOTIA

The location of the 10 coal fields of Nova Scotia is indicated on Map 3 which shows the coal fields of Nova Scotia and New Brunswick. These coal fields may be conveniently grouped as those occurring on Cape Breton Island and those on the mainland. On the east coast of the Island there occurs the Sydney coal field, the most important field in the Maritimes. Several relatively small deposits occur on the west coast at St. Rose-Chimney Corner, Inverness, Mabou and Port Hood. In the south are two very small deposits in Richmond County and at Loch Lomond. On the mainland, the most important deposits occur in Pictou County in the Stellarton-Westville area, and Cumberland County in the Springhill-Joggins area. A small deposit occurs in Colchester County near Kemptown. All the coals of Nova Scotia are bituminous coals. The greater part of the coal produced classifies as high volatile "A" bituminous coal. Some medium volatile coal is produced in the Pictou field and a small amount of high volatile "C" is mined on the west coast of Cape Breton Island. The small deposit in Colchester County classifies as low volatile bituminous coal. The ash content of the Nova Scotia coals varies considerably, but generally it is not excessive in relation to competing bituminous coals in the markets served by Nova Scotia mines. The sulphur content of the coals, however, tends to be relatively high. They are generally good coking coals but this high sulphur content is a handicap in their use for the manufacture of metallurgical coke and of gas. An important feature in regard to the quality of Nova Scotia coals in relation to competing coals is their relatively low fusion point of ash. The range is from 2,025 to 2,490 degrees Fahrenheit.

The coal deposits of the Maritimes all are found in Pennsylvanian strata which extends over large areas there. The coal-bearing horizons are, however, much less extensive and are confined to the upper part of these Carboniferous rocks. Recent geological studies have shown that the coal deposits belong to three age series, the Riversdale, Cumberland and Pictou series, the classifications being made on fossil-plant evidence. There were long intervals in which barren, sandstone and shale were deposited with only relatively short intervals favourable to the growth of coal-forming vegetation. The St. Rose-Chimney Corner, Port Hood and Richmond coal deposits belong to the Riversdale series, the oldest of the series. The Springhill-Joggins deposits belong to the Cumberland or second oldest series. All the other fields belong, together with the New Brunswick deposit at Minto, to the Pictou series. With the exception of the Sydney field, the deposits in Nova Scotia are of small dimensions and, with the exception of the Pictou deposit, were formed from vegetation which grew on the location, the seams being characterized by uniformity of quality and thickness and a clay root-bearing floor. The Pictou deposit appears to have been formed from drifted vegetation, the seams showing wide variations in thickness and quality within short lateral distances and lack the typical clay root-bearing floor.

The readily accessible coal in the land areas of Nova Scotia has been mined, the remaining reserves therefore offer little opportunity of recovery by stripping operations. An exception to this general statement is the outcropping of one or two seams in the Sydney coal field. The land areas contain only very limited deposits, the most important reserves lying in the submarine areas of the Sydney


COALFIELDS OF
NOVA SCOTIA
AND
NEW BRUNSWICK
Prepared by B.R. MacKay, Geological Survey, 1946.
SCALE OF MILES
50
0
50
LEGEND
Productive coalfields, land areas
Submarine extensions of coalfields
Boundary of Upper Carboniferous (Pennsylvanian) Coal Measures
QUEBEC
MAINE
NEW BRUNSWICK
NOVA SCOTIA
PRINCE EDWARD ISLAND
Cape Breton Island
GULF OF ST. LAWRENCE
ATLANTIC OCEAN
BAY OF FUNDY
Northumberland Strait
Chaleur Bay
Magdalen Islands
Minas Basin
Chignecto B.
Chedabucto B.
George Bay
Miramichi B.
Dalhousie
Campbellton
Bathurst
Shippigan
Edmundston
Grand Falls
Newcastle
Chatham
Richibucto
Woodstock
Chipman
MONCTON
FREDERICTON
Fredericton Jct.
McAdam
Sussex
SAINT JOHN
St.Martins
St.Stephen
St Andrews
Grand Manan
Beersville Coal Area
Minto Coalfield
Minto
Joggins Coalfield
Springhill Coalfield
Joggins
Amherst
Springhill
Pugwash
Pictou
Westville
Stellarton
New Glasgow
Thorburn
Kemptown Coal Area
Pictou Coalfield
Truro
Stewiacke
Wolfville
Kentville
Windsor
Bridgetown
Annapolis Royal
Digby
Chester
HALIFAX
Dartmouth
Mahone Bay
Lunenburg
Bridgewater
Liverpool
Rossignol L.
Yarmouth
Shelburne
Liscomb
C.Canso
Summerside
CHARLOTTETOWN
Georgetown
Souris
Chimney Corner-St.Rose Coalfield
Inverness Coalfield
Inverness
Mabou Coalfield
Port Hood Coalfield
Richmond Coal Area
L.Ainslie
Bras d'Or L.
Sydney Coalfield
Sydney Mines
New Waterford
Glace Bay
N.Sydney
Sydney
Loch Lomond Coal Area
C.North
Nipisiguit R.
Tabusintac R.
Saint John R.
Salmon R.
Renous R.
Miramichi R.
St. Mary R.
Mersey R.
Medway R.
Clyde R.
Stewiacke R.
St. Marys R.
C.N.RYS.
C.P.R.
D.A.RY.
48°
47°
46°
45°
44°
69°
68°
67°
66°
65°
64°
63°
62°
61°
60°

coal field. In view of the extensive knowledge of the geology of Nova Scotia, the Commission is advised that there is little likelihood of discovery of further coal deposits, with the exception of the possible field near Newville at Halfway Lake (16 miles southwest of Springhill).

In succeeding pages a brief description of the various coal fields is given, together with an estimate as to the reserve tonnage available for mining.

CAPE BRETON COAL FIELDS

Sydney Coal Field

As previously noted, the Sydney coal field on the eastern part of the Island is the most important field in the Maritimes. It yields about 80 per cent of the total output of coal in Nova Scotia and over 30 per cent of the total Canadian production, and although the field has been extensively mined during the past 120 years its remaining reserves are very considerable. Some particulars of the field appear on Map 4.

The chief centres of population in the area are Sydney, Glace Bay, Sydney Mines and New Waterford, communication with the mainland being maintained by the Canadian National Railways. One important feature of the geographical position of the field is its location on the Gulf of the St. Lawrence with good harbour facilities at Sydney and Louisburg. This is a very considerable asset to the coal industry in the Sydney field, as it provides for cheap water transport to the St. Lawrence Valley and Montreal in particular, to Newfoundland and to points on the Atlantic Coast (notably Halifax and Saint John).

The coal field extends northwesterly from Cape Morien in the east to Cape Dauphin, a distance of about 36 miles. It penetrates inland from the shore to a maximum distance of 8 miles and covers a land area of about 200 square miles. Much of the most readily available and best quality coal of the land areas has been mined. The coal field is terminated by faults on the northwest and southeast, known respectively as the Mountain Fault and the Bateston Fault. The extent of the seaward area between these faults is unknown, but sufficient is known from underground workings at some 3½ miles from shore to indicate the deposit persists beyond the limits of practical mining operations, insofar as the upper seams are concerned.

The productive coal seams occur in the upper third of the Pictou series (known locally as the Morien series). The Pictou series have a maximum thickness of 6,450 feet in the area but vary widely in thickness in different locations. They consist of grey and red sandstones and shale, some arkosic grits, conglomerate beds and a few limestone and shell fossil bands. The upper third of the series is chiefly shales and clays, the productive measures being made up approximately of 2 per cent coal, 60 per cent shale, 15 per cent fire clay and 23 per cent sandstone. There is a gradual gradation from coarse-grained sediments in the western area to fine-grained sediments in the eastern portion of the field. Generally the roof of the coal seams is a weak shale with local occurrences of sandstone. The floor varies from a soft fire clay to a hard shale.

In contrast with other coal fields in the Province of Nova Scotia, the Sydney coal field has suffered little disturbance. Folds are gentle and faults rare. Structurally it is characterized by gentle open folds having four northeasterly plunging synclines, designated the Morien, Glace Bay, Sydney Harbour and Boularderie synclines, separated by intervening northeasterly plunging anticlines known as the Cape Percé, Bridgeport and Boisdale anticlines. The plunge of these structures closely conforms to the true dip of the measures, which is six to seven degrees in a northeasterly direction. The field includes 12 coal seams of commercial importance, ranging in thickness from 3 to 7 feet, 11 of which have been mined. Coastal erosion has attacked the anticlinal folds—thus dividing the coal field into individual basins. In many instances different names have been given to the same seam when worked in different localities. A correlation of the seams was made by the Geological Survey (Robb and Fletcher 1873) and still holds, although some uncertainty still exists as to the correlation of the seams on the north side of Sydney Harbour where some of the seams split and others appear to fail.

All of the coals mined in the field are high volatile "A" bituminous coals broadly conforming to the general description of Nova Scotia coals previously given. However, there is a considerable variation in the quality of the coal recovered from the various seams and between the coals of the various areas. A typical analysis of coal mined in the Sydney area is as follows:

	(As received basis)	
Moisture	Per cent	4.0
Ash	Per cent	8.4
Volatile Matter	Per cent	32.2
Fixed Carbon	Per cent	55.4
Sulphur	Per cent	2.9
Calorific Value	B.t.u./lb.	13,340
F.P.A.	°F	2,025

The Dominion Steel & Coal Corporation Limited submitted the following data to the Commission regarding recoverable coal reserves on leaseholds held by subsidiary companies in the Sydney field.

Name of Company	Estimated Recoverable Coal—Long Tons		
	Developed Reserves*	Other Coal Resources*	Total
Dominion Coal Co. Ltd.	402,800,000	389,966,000	792,766,000
Cumberland Rly. & Coal Co.		13,000,000	13,000,000
N.S. Steel & Coal Co.	42,250,000	163,450,000	205,700,000
	445,050,000	566,416,000	1,011,466,000

* The term 'developed' reserves is used in contradistinction to reserves of more doubtful value. 'Other Coal Resources' covers seams which, in the opinion of the Company, may be of less value than those now being worked or which by reason of physical conditions cannot be profitably mined at the present time. Also included in this category are seams which cannot be now proven on account of inaccessibility and where the evidence indicates a progressive deterioration in quality. Estimates of recoverable coal are based on:

(a) Presence of coal seam in workable height and quality.
(b) Underground development to a maximum distance of 5 miles from mine opening.
(c) Maximum depth of cover of 4,000 feet.
(d) Percentage of recovery in actual current mining operation.

On the basis of this estimate and an annual production of 5,500,000 tons, the company foresees some 80 years of operations on developed reserves alone, a further 100 years of operations being suggested in the estimate of other coal resources. The following table is an estimate of the life of the various collieries operated by Dosco subsidiary coal companies in the Sydney coal field as submitted by the company.

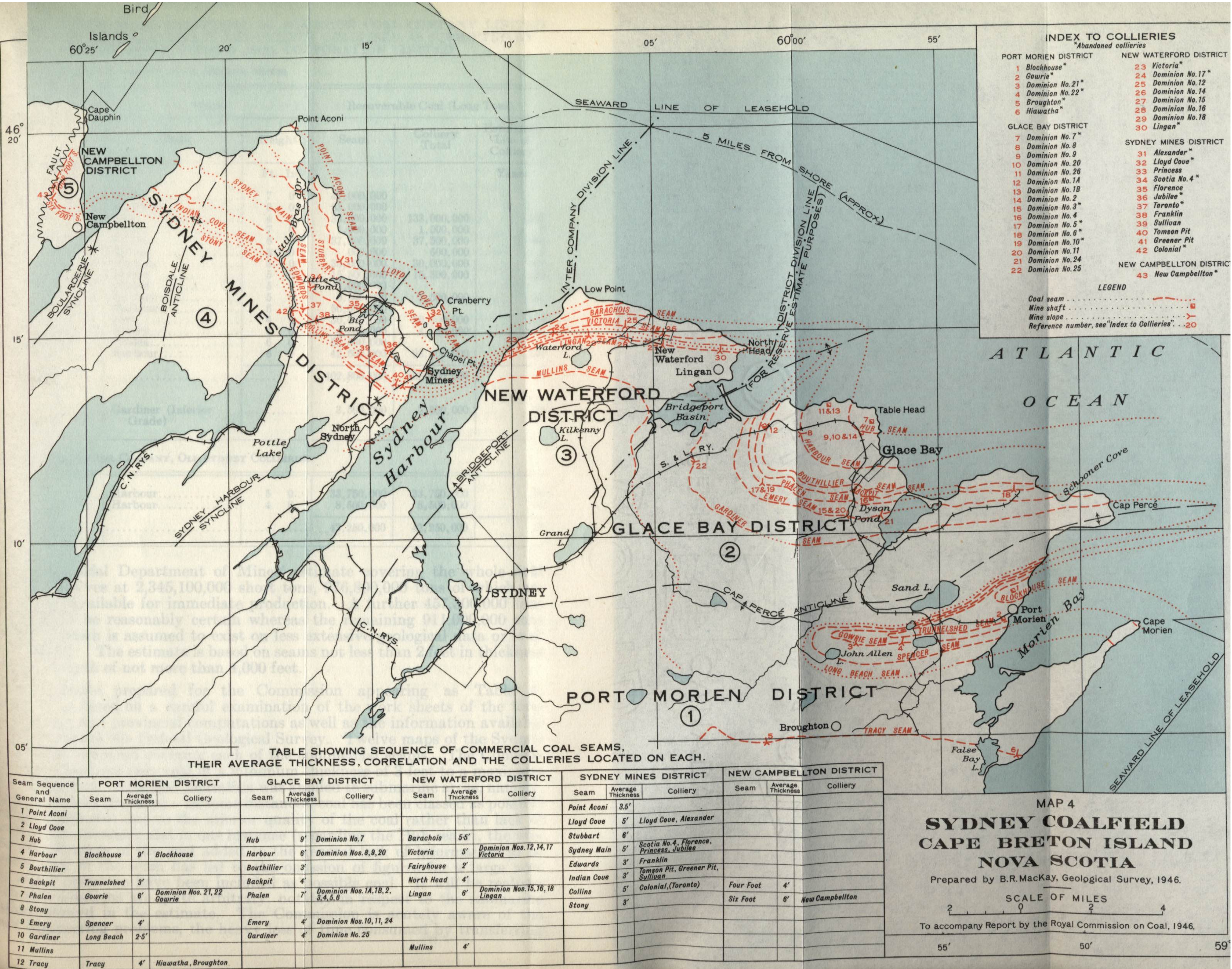


TABLE SHOWING SEQUENCE OF COMMERCIAL COAL SEAMS, THEIR AVERAGE THICKNESS, CORRELATION AND THE COLLIERIES LOCATED ON EACH.

Seam Sequence and General Name	PORT MORIEN DISTRICT			GLACE BAY DISTRICT			NEW WATERFORD DISTRICT			SYDNEY MINES DISTRICT			NEW CAMPBELLTON DISTRICT		
	Seam	Average Thickness	Colliery	Seam	Average Thickness	Colliery	Seam	Average Thickness	Colliery	Seam	Average Thickness	Colliery	Seam	Average Thickness	Colliery
1 Point Aconi										Point Aconi	3.5′				
2 Lloyd Cove										Lloyd Cove	5′	Lloyd Cove, Alexander			
3 Hub				Hub	9′	Dominion No.7	Barachois	5·5′		Stubbart	6′				
4 Harbour	Blockhouse	9′	Blockhouse	Harbour	6′	Dominion Nos.8,9,20	Victoria	5′	Dominion Nos.12,14,17 Victoria	Sydney Main	5′	Scotia No.4, Florence, Princess, Jubilee			
5 Bouthillier				Bouthillier	3′		Fairyhouse	2′		Edwards	3′	Franklin			
6 Backpit	Trunnelshed	3′		Backpit	4′		North Head	4′		Indian Cove	3′	Tomson Pit, Greener Pit, Sullivan			
7 Phalen	Gowrie	6′	Dominion Nos. 21, 22 Gowrie	Phalen	7′	Dominion Nos.1A,1B,2, 3,4,5,6	Lingan	6′	Dominion Nos.15,16,18 Lingan	Collins	5′	Colonial,(Toronto)	Four Foot	4′	
8 Stony										Stony	3′		Six Foot	6′	New Campbellton
9 Emery	Spencer	4′		Emery	4′	Dominion Nos.10,11, 24									
10 Gardiner	Long Beach	2·5′		Gardiner	4′	Dominion No.25									
11 Mullins							Mullins	4′							
12 Tracy	Tracy	4′	Hiawatha, Broughton												

ESTIMATED RESERVES BY COLLIERIES OF DOMINION COAL COMPANY LIMITED AND OLD SYDNEY COLLIERIES IN THE SYDNEY COALFIELD AS SUBMITTED BY THE DOMINION STEEL & COAL CORPORATION LIMITED

Dominion Coal Company Limited, Cape Breton Mines

Colliery	Seam: Name	Seam: Height Ft.	Seam: Height In.	Recoverable Coal (Long Tons): Seam	Recoverable Coal (Long Tons): Colliery Total	Estimated Life of Colliery (Years)
No. 1B	Phalen	7	0	47,000,000		
	Harbour	6	0	53,000,000		
	Hub	4	6	33,000,000	133,000,000	165
No. 2	Phalen	7	0	1,000,000	1,000,000	6
No. 4	Phalen	6	0	37,500,000	37,500,000	94
No. 11	Emery	3	0	600,000	600,000	4
No. 12	Harbour	5	0	30,000 000	30,000,000	60
No. 16	Phalen	5	0	15,500,000	15,500,000	30
No. 18	Phalen	5	0	1,000,000		
	Harbour	5	0	6,500,000	7,500,000	31
No. 20	Harbour	6	0	50,000,000		
	Hub	4	6	30,000,000	80,000,000	109
No. 24	Emery	3	0	4,300,000	4,300,000	16
Reserve for New Colliery	Phalen	6	0	50,800,000		
	Harbour	6	0	42,600,000	93,400,000	154
Total				402,800,000	402,800,000	90
No. 25	Gardiner (Inferior Grade)			3,500,000	3,500,000	25

Nova Scotia Steel & Coal Company, Old sydney Collieries

Colliery	Seam: Name	Seam: Height Ft.	Seam: Height In.	Recoverable Coal (Long Tons): Seam	Recoverable Coal (Long Tons): Colliery Total	Estimated Life of Colliery (Years)
Princess	Harbour	5	0	33,750,000	33,750,000	84
Florence	Harbour	4	0	8,500,000	8,500,000	34
Total				42,250,000	42,250,000	52

The provincial Department of Mines' estimate covering the whole field placed the reserves at 2,345,100,000 short tons, 976,800,000 tons of which are considered as available for immediate production. A further 457,300,000 tons are thought to be reasonably certain whereas the remaining 911,000,000 tons include coal which is assumed to exist on less extensive geological data or is of inferior quality. The estimate is based on seams not less than 2 feet in thickness at a vertical depth of not more than 4,000 feet.

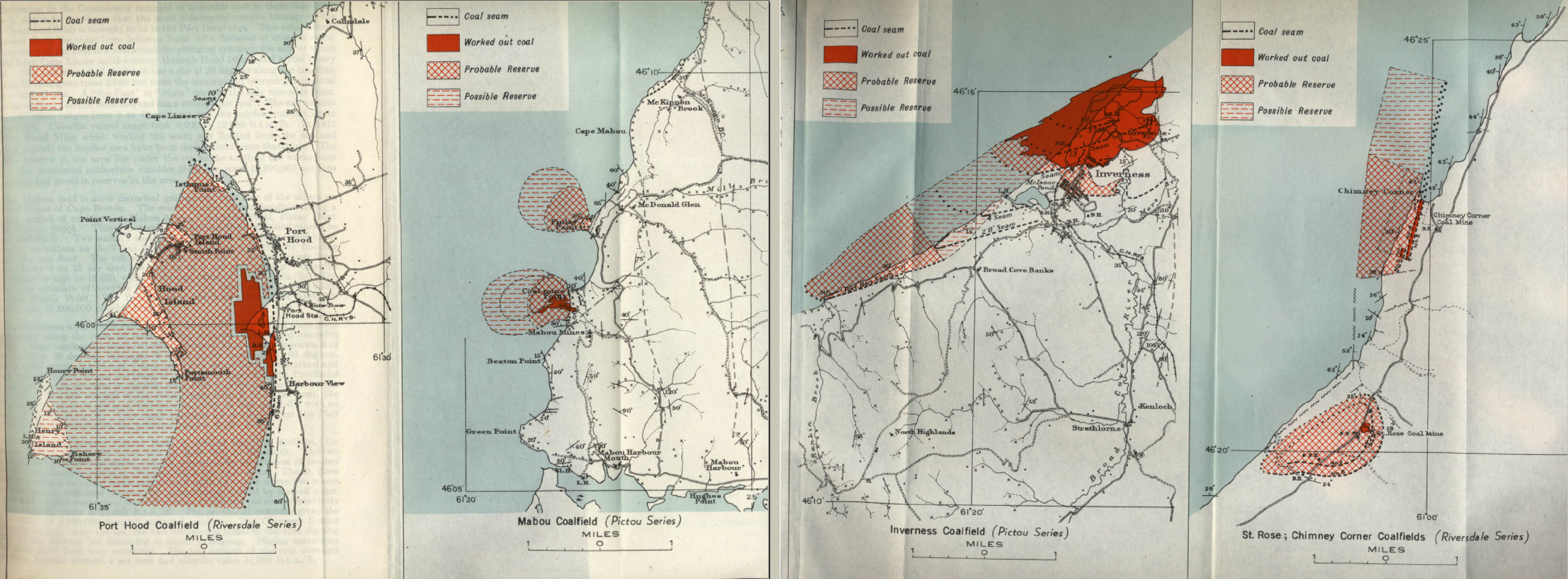
The estimate prepared for the Commission appearing as Table 4, Appendix A, is based on a careful examination of the work sheets of the foregoing company and provincial computations as well as the information available from the records of the Federal Geological Survey. Twelve maps of the Sydney coal field were prepared covering each of the commercial seams. The Commission estimate includes only coal of a minimum thickness of 3 feet to a maximum depth of 4,000 feet. A further limitation was applied to submarine areas, namely, a 5-mile limit from the shore. In some instances, coal has been classed as possible rather than probable due to the inferior quality of the coal rather than lack of evidence of its existence, and in one instance (regarding the Hub seam), the presumed deterioration of the coal added to the general lack of information as to the continuity of the seam has led to the omission of figures for a large area which might otherwise have been included as possible coal. It will be realized that these limitations are quite arbitrary, notably in respect to the submarine extension allowed in the estimate. The Commission is acutely aware of the difficult engineering problems, the heavy loss of time consumed by transferring workers from the mine entry to the face and other high cost factors involved in submarine mining to such distances. At the same time technical advances in rapid underground transport, the development of cross-measure haulage tunnels and improved power transmission may increasingly allow such operations, and it is noted that the distance at which coal is now being recovered from under the sea is far greater than the pioneers of submarine coal mining had originally visioned as feasible. We are advised that seams below the Phalen seam will probably reach the limit of mineability either by thinning or by depth of cover before reaching the 5-mile limit. It is thought that non-persistence or deterioration in quality will limit mining operations in the Phalen seam and seams above it on the western and eastern parts of the field, whereas some of the upper seams will persist in commercial thickness and quality beyond the arbitrary 5-mile limit. Relatively little is known of the behaviour and quality of some of the upper seams, notably the Point Aconi seam, which outcrops very largely at sea, and the characteristics of submarine extensions of other seams are only a matter of deduction from meagre information. Apart from the outcropping of the Point Aconi seam in the Point Aconi area where stripping operations of a local nature may be possible, the efficient recovery of coal will generally involve large scale operations and their submarine extension. The Commission estimate gives overall figures of 1,764,184,000 short tons of probable mineable coal and a further 915,152,000 tons of possible coal. These figures are divided in half for an estimate of recoverable coal.

As might be expected there are considerable differences in these three estimates and these are partly explicable in terms of the different bases on which they are compiled. However there is general agreement that there are extensive coal reserves in the Sydney coal field. By common consent the life of the field will not be determined by the failure of the coal deposit, but will depend on ability to recover the coal at reasonable costs.

West Coast Coal Fields

As will be seen from Map 5, there are four coal basins on the west coast of Cape Breton extending from Port Hood northeasterly to Chimney Corner, a distance of some thirty-five miles. In order of occurrence and proceeding northward they are the Port Hood, Mabou, Inverness and St. Rose-Chimney Corner basins. The Canadian National Railways link three of the areas with the Mainland but the St. Rose-Chimney Corner area does not have railway service.

It will be recalled that the geological age of the deposits varies, the St. Rose-Chimney Corner deposit in the north and the Port Hood deposit in the south being of Riversdale age, and the Central Inverness and Mabou basins belonging to the younger Pictou series. It is possible that these two latter fields were once part of a continuous field now submerged beneath the Gulf of St. Lawrence but they are now structurally separated units. Mining operations have been carried out at various times in all of these locations and the land areas are now largely depleted with the exception of the St. Rose section of the St. Rose-Chimney Corner basin and a section of the Inverness basin. Characteristically the seams dip steeply at their outcrops, usually to sea, the angle of dip ranging from 45 degrees to 30 degrees, later flattening to an angle of 10 to 15 degrees at 2,000 feet from the outcrop. The West Coast coals are of lower rank and grade than coals of the Sydney coal field, and classify as high volatile "C" bituminous coals. Their ash and sulphur contents are higher than the Sydney coals, and they have a tendency to spontaneous combustion when stored in large quantities. The West Coast coals, however, have free-burning characteristics and are, therefore, more suitable than Sydney Coals for domestic consumption in hand-fired equipment. The quality of the coal seams on the West Coast, their inclination and almost entirely submarine position, restrict their immediate economic importance. It is apparent that mining in these fields will be largely confined to production for the local domestic market until such time as the reserves of the Sydney coal field are depleted.



MAP 5 Coalfields of Inverness County, West Coast Cape Breton Island.

Reference to the Commission estimate of mineable coal in these fields (see Table 5, Appendix A) shows that the most substantial reserve tonnage of the West Coast coal fields is thought to be in the Port Hood area. This area extends southward along the coast from Isthmus Point for a distance of about 5 miles. The structure of the field is a southwesterly-plunging syncline, the axis of which extends from Cape Linzee southwesterly through Hood Island and across Henry Island. The eastern part of the basin has a dip of 20 degrees along the coastline lessening to 15 degrees some 2,000 feet from the outcrop and becoming horizontal at the synclinal axis. A "Six-Foot" or "Main" seam is the only mineable seam. It averages about 5 feet in thickness and has a strong shale roof. The ash content of the coal seam ranges from 6 to 18 per cent and the sulphur content up to 8.5 per cent. Calorific values range from 9,900 to 12,000 B.t.u./lb. In 1911 the Port Hood Mine which worked the seam was flooded from the sea and workings outside the flooded area have been intermittent since that time. The mineable reserve in the area lies under the sea to the south of the worked-out areas. The provincial authorities consider there are some 10,000,000 net tons of potential and possible reserves in the area.

The Mabou field is more disturbed geologically than any of the others on the West Coast of Cape Breton. The seams outcrop at four localities along a four-mile stretch of coastline, at Mabou Mines, Coal-Mine Point, Finlay Point and McKinnon Brook. They dip steeply seaward and their extension cannot be forecast definitely. Two seams, 7 and 8 feet in thickness, have been mined intermittently, operations on the 7-foot seam being terminated in 1909 by flooding through the sea floor. The ash and sulphur contents of the coal range from approximately 5 to 25 per cent ash and up to 6 per cent sulphur. Calorific values range as high as 13,650, with an average value of 10,900 B.t.u./lb. The Commission estimate of reserves is limited to two small areas at Coal-Mine Point and Finlay Point. The Province gave the field a reserve of 5,000,000 potential and 27,000,000 possible tons.

The Inverness area, which extends from the mouth of the Broad Cove river southeasterly along the coast for some 6 miles, contains very limited mineable reserves. Four commercial seams outcrop in the area, all of which dip seaward at angles of 15 to 30 degrees, the angle of dip in places increasing to 60 degrees. Three of these seams, the 13-foot, 7-foot and 4-foot seams have been worked and mining has advanced beyond the point of commercial operation, the Provincial Government having operated in the field since 1933 in order to give relief to the community. The ash content of the coals ranges from 6 to 25 per cent, the sulphur content up to 10 per cent, and calorific values as high as 12,400 with an average of 11,000 B.t.u./lb. Very small tonnages are available from the Port Ban Seam, which constitutes the principal reserve in the field.

The St. Rose-Chimney Corner basin is divided into two sections, the Chimney Corner field in the north and St. Rose field to the south. The two fields contain the same coal seams but are separated by an interval of faulted strata of approximately 2 miles in which no coal is known to occur. The St. Rose deposit is confined to a land basin measuring 2 miles by 1 mile where two seams of 6 and 7 feet in thickness outcrop, the former being worked by a small mine. The ash and sulphur contents of the coal average 11.8 and 7 per cent respectively and the calorific value is 11,660 B.t.u./lb. The provincial estimate gives the area a total of 8,850,000 tons of potential reserves. The Chimney Corner reserves lie largely under the sea, the two commercial seams of the area dipping steeply at the outcrop but flattening to about 18 degrees. Mining operations in the area have been very restricted. The ash content of the coal averages 8 per cent, sulphur content 4 per cent and calorific value 11,000 B.t.u./lb.

Richmond-Loch Lomond Areas

Comparatively little is known about these two coal areas. In the River Inhabitants basin of Richmond County, coal outcrops have been discovered at various points. One seam with numerous included dirt bands is 11 feet thick. The coal is high in ash and sulphur, and the measures are considerably deformed. It is, therefore, unlikely that the field will ever be of more than local significance. Some small tonnage has been mined for local usage and the Province suggests that there are remaining reserves amounting to 5,000,000 tons of potential and 5,000,000 of possible coal.

The Loch Lomond basin which lies to the northeast may be an outlying remnant of the Sydney coal field but has never been drilled to establish this or the extent of the deposit. One seam on the northern outcrop of the basin has been worked to a very limited extent and the area is believed to contain reserves which will have local significance. The coal is reputed to have a low sulphur and ash content and to be suitable for metallurgical purposes. No estimate of the reserve was given by the Province. The Commission estimate for these two areas appears in Table 5, Appendix A.

THE MAINLAND COAL FIELDS

Pictou Coal Field

The Pictou coal field, which is one of the remaining important coal fields in Nova Scotia, has its centre at Stellarton 2 miles south of New Glasgow. The field extends about 6 miles to the east beyond Thorburn, and westward to about 3 miles beyond Westville, and is about 3 miles across in its north-south axis. The area is served by the main line of the Canadian National Railway from Truro to Sydney, and from Stellarton a branch line runs to Pictou Landing from whence the trans-shipment by water can be effected to points on the St. Lawrence. New Glasgow is the community centre, the mining towns being Stellarton, Westville and Thorburn.

The coal field is bounded by faults of large displacement, and consists of three separate mining areas, which from west to east are the Stellarton, Westville, and Thorburn areas. Faults separate these from one another, but the displacement between the Thorburn and Stellarton coal areas is not so pronounced as that which separates the Stellarton and Westville areas. The coal measures in the Stellarton area, and to a lesser extent those in the Westville area, have been further cut by cross-faults, with the result that the coal seams have been sufficiently displaced as to seriously handicap mining operations. The coal seams of each of these areas belong to the Pictou series (known locally as the Stellarton series) but occur in three different geological formations of the series. Those occurring at Westville are the older and belong to the Westville formation; those at Stellarton belong to an intermediate formation known as the Albion formation; and those at Thorburn belong to the youngest formation in the field designated the Thorburn formation.

In the Westville area there are at least 4 seams, 2 of these, the Acadia and Scott seams, having thicknesses of 17 and 12 feet, constitute the main reserve of the area. The two lower seams, each having an average thickness of 6 feet, are of inferior quality and have remained largely unprospected. Their behaviour is therefore relatively unknown.

In the Stellarton area there are at least 10 seams, 5 of which have been mined. They have thicknesses ranging from 8 to 40 feet and have been the main source of production in the Pictou field. The other 5 are known only from a few drill holes put down from the mine workings in the Acadia No. 1 seam, the lowest seam so far worked in the Stellarton area, but are not believed to be of commercial importance.

In the Thorburn area there are 5 seams, 4 of which are over 3 feet in thickness. All of these have been extensively mined, but substantial reserves remain in the lower two seams, namely, the Six-Foot and McBean seams.

The Thorburn area is well defined, being a separate shallow structural basin in which the coal seams outcrop on the eastern and western rims, but are cut off by faults on the south and north. This is in marked contrast to the Stellarton and Westville areas where the coal seams dip from their outcrops northward at angles of from 20 to 25 degrees for a distance of almost a mile before being cut off by faults of large displacement.

One feature of the Pictou coal field is that the deposits of the Westfield and Stellarton areas, and to some extent those of the Thorburn area, give evidence of having been formed from an accumulation of drifted vegetation. In this, the deposits differ from those of the other coal areas of the Maritimes. The mode of origin of these deposits has affected the quality of the coal and has a direct bearing on mining practices in the field. The fact that the coal-making material was washed or rafted into place has given rise to great variation within short distances in the thicknesses of the coal deposits and the intervening sediments. This is shown to a marked degree in the case of the Foord seam at Stellarton, which ranges up to 40 feet in thickness. The Foord seam and the underlying Cage seam near the outcrop are separated by a stratigraphical interval of 150 feet, whereas at the bottom of the basin, 3600 feet below the outcrop, the seams are only 10 feet apart. The mode of deposition has given rise also to wide variations in the quality of the coal. In particular the admixture of silt and finely-divided mineral matter with the rafted vegetation has resulted in the coal having a relatively high ash content, the ash being dispersed throughout the coal, with the result that its removal by hand picking and simple preparation is difficult. Again deposition of the vegetal matter under moving currents of water tended to separate the finer divided vegetal matter such as spores and leaves, and to concentrate them in sections of the seam so as to form lenses and stringers of carbonaceous matter differing from the main body of the coal. The presence of such lenses tends to increase the possibility of spontaneous combustion, a factor which has been a definite hazard to mining operations in the Pictou field, particularly in the Stellarton workings.

The Pictou coal field in relation to its size is the most extensively exploited coal field in Canada, some 75 million tons having been mined in the area over a period of about 125 years. As a result of this extensive mining, most of the readily accessible coal has been recovered, and the field has now arrived at what might be termed its final stage of commercial operation. The remaining large reserves in the area are found in the McBean and Six-Foot seams of the Thorburn area, the Foord seam of the Stellarton area and the Acadia (or Main) and Scott seams of the Westville area, the latter seam being of somewhat inferior quality.

The Acadia Coal Company, the principal operator in the field, estimates on the basis of its own leases and the current level of production, a future life for the field of between 40 and 50 years, the figures being as follows:

	Long tons
Developed Reserves	13,540,000
Other Coal Resources	14,400,000
Total	27,940,000

The Provincial Government's estimate suggested more extensive reserves may be available in the field, notably in the instance of the Stellarton area.

Dr. MacKay's estimate (see Table 6, Appendix A) substantially agrees with the Company's estimate, but also indicates, in line with the Provincial estimate, that the reserves may prove more substantial than presently anticipated, in which case operations, probably of a more limited nature than those of today, may continue beyond the period suggested by the Acadia Coal Company.

Coal Fields of Cumberland County

There are two separate coal areas in Cumberland County which lies to the west of Pictou County. These are the Springhill and the Joggins coal fields. The two areas are separated by a broad southwesterly-plunging syncline consisting of barren rock. The workable seams in both areas are of the same broad geological age, being confined to the Cumberland series of the Upper Carboniferous (Pennsylvania) rocks. The seams in the Joggins area lie in the lower part of the series, whereas those of the Springhill area are younger, and are found in the upper portion of the series. The main reserves in the county are found in the Springhill area.

The centre of the Springhill coal field is at Springhill which is some 5 miles southeast of Springhill Junction on the Canadian National Railways. The coal seams outcrop over a distance of about 6 miles, but the productive measures are confined to about 2 miles, the seams on either side becoming progressively invaded by bands of stone rendering them unmineable. The Cumberland Railway and Coal Company, the sole operator in the field, owns and operates a railway which runs from Springhill Junction on the main line of the Canadian National Railways through Springhill to Parrsboro, a distance of 32 miles. Parrsboro is located on the shore of Minas Basin to the southwest of Springhill, and is the site of a shipping pier from which coal can be shipped to ports on the Bay of Fundy.

The seams lie on the northwestern flank of a southwesterly-plunging anticline and dip at the outcrop at angles as high as 60 degrees, the average being 32 degrees. The angle of inclination gradually flattens with depth. The No. 2 seam, which has been mined to a depth of 3,821 feet, or a distance of 11,400 feet from the outcrop, has at the lowest workings a dip of 12 degrees. Six seams occur in the formation ranging in average thickness from 4.5 to 10 feet. All of these seams have been mined for distances ranging from 1,000 feet to a maximum distance of over 11,000 feet. These six seams are contained within about 1,200 feet of measures being separated from one another by intervening strata of interbedded sandstones and shales ranging in thickness from 70 to 700 feet. The presence of strong sandstone strata above or below the coal seams provides ideal conditions for mining, and has allowed the extraction of the full thickness of 9 feet of coal from No. 2 seam at a depth of over 3,800 feet. On the other hand the nature of the measures presents a serious handicap to deep mining operations. At depth, the extraction of coal results in transference of the load of the overlying strata to the coal seam in advance of the workings, but this transference is delayed by the existence of the strong sandstone bands abovementioned, causing accumulation of the stresses in the sandstone to a point where the band fractures suddenly, and transmits the whole accumulated stress suddenly, without warning or previous signs of distress, to the weaker coal seam, which explodes, or "bumps," hence the local name for these outbursts. Whereas these conditions may not prevent further mining of the seam, the occurrence of "bumps" has led to the abandonment of a number of sections of the field in favour of areas where more flexible surrounding rocks permit the safe extraction of the coal.

The coal in the Springhill area classifies as high volatile "A" bituminous coal, and is a good coking coal. A typical analysis is as follows:

	(As received basis)	
Moisture	Per cent	2.8
Ash	Per cent	9.7
Volatile Matter	Per cent	29.9
Fixed Carbon	Per cent	57.6
Sulphur	Per cent	1.6
Calorific Value	B.t.u./lb.	13,225
F.P.A.	°F	2,255

Coal has been extracted from the Springhill coal field for the past 75 years, and like the Pictou coal field, the more readily accessible coal has been mined. It is extremely difficult to arrive at any forecast of the reserves of the coal field because of two factors, the nature of the deposit and the structural deformations that have taken place since its deposition. The evidence suggests that the deposits were laid down in a valley between mountains and thus were confined to a limited area. Moreover the vegetation on the fringes of this narrow basin was contaminated by a constant influx of sands and silts carried into the valley from the surrounding areas by streams. As a result the coal seams in the marginal areas are characterized by an interbedding of coal and rock. Thus, although some of the coal seams have been traced for a distance of 6 miles along the outcrop, the productive field has been found to be limited to a distance of about 2 miles, the quality of the seams deteriorating seriously beyond this limit. On the other hand, the folding and faulting to which the coal measures in the southern part of the field have been subjected suggest that there are probably pockets of good quality coal outside of this 2-mile limit. These pockets would result from the pressure of the strata on the coal at the time of folding which had the effect of squeezing out the coal from the most tightly compressed parts of the fold and transferring it to the areas of easier compression. Dr. MacKay advised the Commission that our estimate of possible reserves includes some allowance for such occurrences.

The company's estimate of reserves which is given below is based on an intimate knowledge of the developed portion of the field, and on the basis of the current level of production the company considers that the life of the field is limited to 25 to 40 years:

	Long tons
Developed Reserves	17,500,000
Other Coal Resources	600,000
Total	18,100,000

The provincial estimate of reserves indicates agreement with the company figures in respect to assured reserves. It is apparent, however, from the large estimate of possible coal, amounting to 156,200,000 net tons, that the provincial authorities consider the field to have a much greater life-expectancy.

The Commission is advised that the company's estimate is conservative. As will be seen from Dr. MacKay's estimate (see Table 7, Appendix A) it is considered likely that the field will have a more extended life than the company figures suggest, but his figures are very considerably less than those of the province.

The Joggins coal field extends from Chignecto Bay eastward to beyond Styles Brook for a distance of about 19 miles. Some mining has been done under Chignecto Bay and the westward limit of the deposit has not been determined. The principal mining centre is Joggins, with smaller operations at River Hebert, Maccan and Chignecto. Maccan lies on the Canadian National Railways' main line, and spur lines owned by the Maritime Coal Railway and Power Company connect Joggins, River Hebert and Chignecto with the Canadian National Railway at Maccan. Mining operations have been carried on in the field for about 100 years, and all the most readily accessible coal has been extracted.

The coal seams of the Joggins field occur on the north limb of a broad southwesterly-plunging syncline, the axis of which lies about midway between this field and the Springhill field. The seams dip to the south at angles ranging from 18 to 25 degrees. In the Joggins area of the field there are 5 seams, all of which are now being mined. Only one of these has a maximum thickness of more than 3 feet. Traced eastward and in depth these seams thin progressively and deteriorate in quality, and some of them peter out. At River Hebert only 4 seams are present, and 2 seams only outcrop at Maccan and Chignecto. All of these seams are being mined even though the seam is less than 20 inches thick. The field is cut by numerous cross-faults of sufficient displacement to hamper mining operations, and where they permit the infiltration of water they have led to the abandonment of collieries.

The coal in this field is classified as high volatile "A" bituminous coal but is of low grade because of high ash and sulphur contents. A typical analysis of the coal is as follows:

	(As received basis)	
Moisture	Per cent	4.5
Ash	Per cent	18.4
Volatile Matter	Per cent	32.2
Fixed Carbon	Per cent	44.9
Sulphur	Per cent	6.0
Calorific Value	B.t.u./lb.	10,900
F.P.A.	°F	2,060

The provincial estimate places the reserves of the Joggins field at 16,020,000 short tons of probable coal with an additional 142,000,000 tons of potential and possible coal.

The Commission estimate places the mineable reserves at about 47 million tons of probable coal with an additional 41 million tons of possible coal. Both estimates placed the principal reserves in the Maccan area. Whereas the Commission estimate of probable coal is higher than that of the province, the overall figures of our estimate are very much lower. These figures would seem to conform with the submission of the Nova Scotia Department of Mines that "Although reserves are limited, this field (Joggins) should be capable of restricted production for some time."

As previously noted, it is possible that a concealed coal field may be present near Springhill on the east side of Fullerton Lake about 13 miles southeast of Joggins. This possibility is based on a report that a borehole put down by the Standard Coal and Railway Company prior to 1904 penetrated nine feet of coal at a depth of 2,550 feet.

Colchester County

Outcrops of coal occur at several places in Colchester County, including Riversdale, Campbell Siding, Debert and Kemptown. These outcrops are believed to be reappearances of a single seam. The geological age of this deposit has not been determined, but it is thought to be of Riversdale age. The seam has been mined to a very limited extent near Kemptown, which lies near the Canadian National Railway line from Truro to Sydney, about 12 miles east of Truro. These operations have indicated that the deposit may be badly disturbed by folds and broken by faults. Where traced, the seam is thin, nowhere having an average thickness of more than 3 feet.

The coal is of relatively high rank, classifying as low volatile bituminous coal. It is, however, of low grade due to its high ash content, 28 tests of the coal in the Kemptown area showing an average ash content of 17 per cent. Its calorific value ranges from 10,750 to 14,450 B.t.u/lb. and averages 12,200 B.t.u./lb. The coal is thought to be amenable to washing.

It is suggested by the Provincial Government that this deposit may assume added value if further investigations of the coal prove it is suitable for mixing with the Sydney coals in the production of metallurgical coke. Very little, however, is known of the extent of the deposit and present information suggests that it has very limited significance. The provincial estimate of reserves is restricted to 1,000,000 tons of possible coal. According to Dr. MacKay's estimate of 1,180,000 tons of probable recoverable coal, and 3,360,000 tons of possible recoverable coal, the field has greater possibilities than suggested by the provincial figures.

SUMMARY

Reference to Table 3, Appendix A, shows that, according to the Commission estimate, Nova Scotia reserves of mineable coal are approximately 1,967,000,000 tons of probable coal with an additional 1,147,000,000 tons of possible coal. Recoverable coal would be about 50 per cent of these figures. A very large proportion of these reserves is contained in the Sydney coal field and it is apparent that this field will be increasingly the centre of production of coal in the Province. We feel the remarks of the Provincial Deputy Minister of Mines summarize effectively the general reserve situation in Nova Scotia when he stated:

> "Although the remaining reserves are very much less than those formerly estimated, there is no immediate shortage of coal substance. The limits of production will be set not by lack of coal but by economic factors of mining costs, coal quality and ways of mining it."

PROVINCE OF NEW BRUNSWICK

As will be seen from Map 3, an extensive area of New Brunswick totalling more than 10,000 square miles is underlain by Upper Carboniferous rocks of Pennsylvanian age, being an extension of the coal-bearing formations of Nova Scotia of the same age. However, only a very limited section of the extensive coal-bearing areas of New Brunswick is known, as yet, to contain coal deposits which admit of commercial development. This section is the Minto coal field or Grand Lake coal-basin situated immediately north of Grand Lake.

About 50 miles northeast of this area, there is a further deposit, the extent and value of which cannot be readily determined on the information currently available. Mining operations along Coal Branch River have shown this deposit to extend from Coal Branch on the Canadian National Railway for a distance of about 10 miles northeast to Beersville. Very limited development work only has been carried on in the area, a few hundred tons being mined annually. The seam is known to be of the same horizon as that occurring in the main Minto field but is thinner in this area. Where mined, it has ranged from 13 to 18 inches with an average thickness of 15 inches. The coal seam appears to have a general dip to the northeast, the overburden ranging from 20 feet at Coal Branch to 100 feet at Beersville. Development work suggests that the seam is continuous throughout the area and maintains uniformity in thickness and quality. Due to the relatively thick overburden at Beersville, little, if any, prospecting has been done in the area to the northeast and it is impossible to determine how far the deposit continues in this direction. At the present time, only a small portion of the field has been taken up, an area of some 120 acres being held under lease, and 80 acres being held under mining licences. One mining claim of 40 acres is in effect.

No figures covering the coal reserves in the Beersville area are included in the Commission's estimate due to the relatively small amount of information available on the reserves and the very doubtful possibility of commercially mining a seam of this thinness and quality.

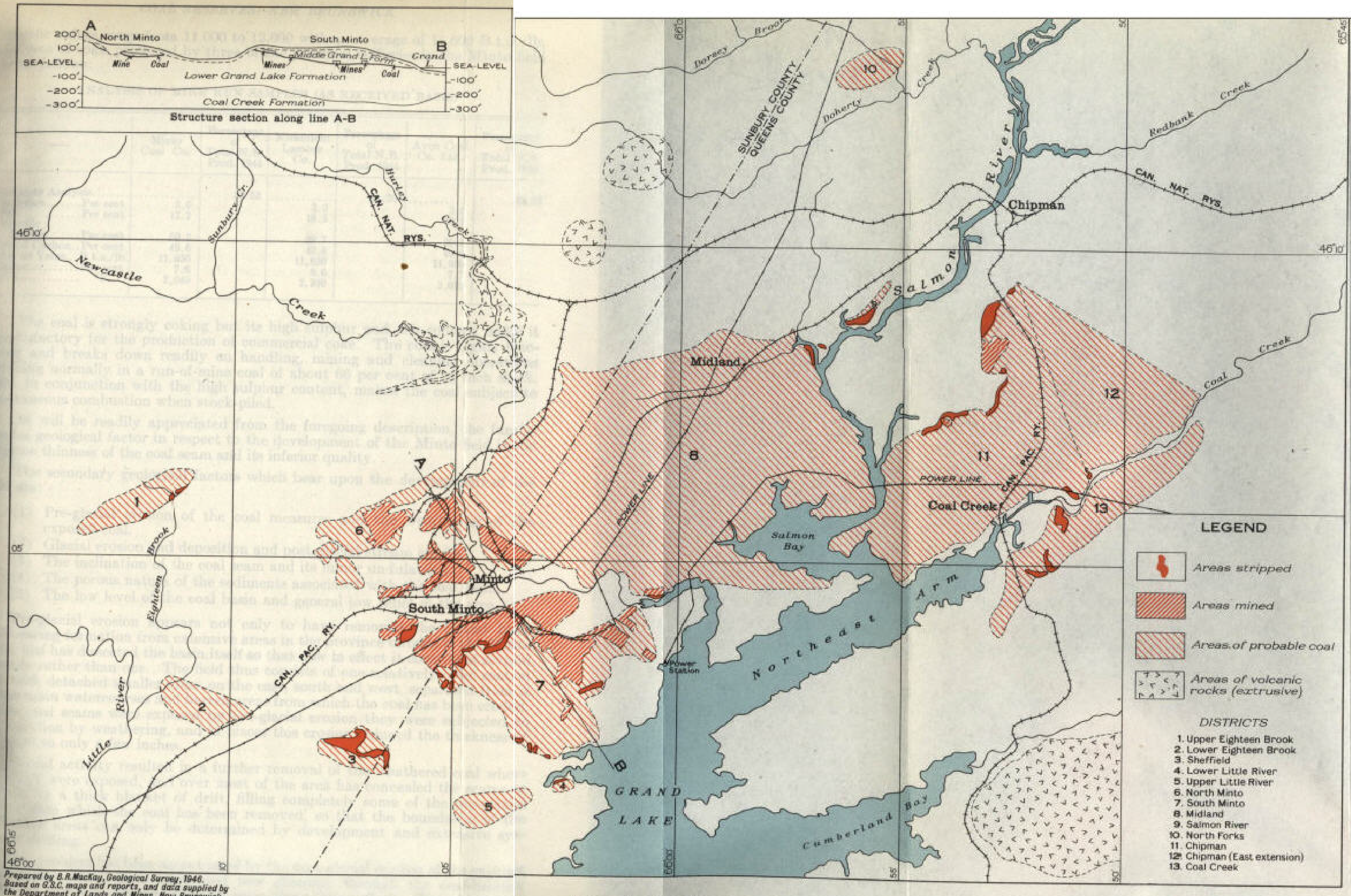
Outside of these two areas coal has been reported at 76 localities widely scattered through 12 counties in the Province. Some of these are known to consist of isolated occurrences. Most of them consist of coal seams less than one foot in thickness. On the present evidence it does not appear that they have any economic value, and the chances of discovering new coal fields of commercial importance in New Brunswick are considered remote.

The Minto Coal Field

As will be seen from Map 6, the Minto coal field is centrally located in southern New Brunswick at the northern end of Grand Lake. The centre of the field is about 33 miles northeast of Fredericton, 58 miles due west from Moncton, 55 miles due north of Saint John, and 65 miles southwest from Newcastle. Minto and Chipman are the chief centres of population. The region is gently undulating with a maximum relief of 500 feet. It is drained by the Salmon River, Newcastle Creek, Little River and Coal Creek which flow southerly into Grand Lake. The mines lie amid very poor farm lands and wood lots, with unbroken forests to the northwest. They are served by the Canadian National and the Canadian Pacific Railways, and by good roads. Barges may be moved through Grand Lake to Saint John and Fredericton via the St. John River.

Briefly described, the Minto coal field is a shallow structural basin of the Grand Lake formation covering an area about twenty miles in length and five to six in width. The longer axis of the basin extends from near the junction of Eighteen Brook and Little River northeasterly to cross Newcastle Creek about a mile north of Minto where it continues in a more easterly course about half a mile west of Salmon Bay eastward through to the valley of Coal Creek. As previously noted it is a remnant of the pre-glacial erosion which removed many thousands of feet of coal-bearing sediments from vast areas of the Province. The coal seam occurs in the central part of the Grand Lake formation which consists of massive and laminated sandstone separated by impervious shale. All the coal mined in the Minto field is from the main or surface seam. The seam varies in thickness from 16 to 30 inches, averaging about 18 inches, being thickest in the southwestern section of the field and thinning out in the northern and eastern parts of the fields, in some places being represented by only a few inches of carbonaceous material. Over large areas, the seam is fairly uniform in thickness and quality, the only very variable features of any importance being the presence of one or more partings and an occasional fault of small displacement. A number of very thin lower seams are present in places but apart from the Minto district where one or more 2- to 6-inch seams are commonly associated with the main seam and in some operations are mined with it, they are not of economic importance. The coal is usually underlain by 2 to 4 feet of root-bearing fire clay, and is overlain by 2 to 5 feet of laminated greenish-grey shale. Throughout most of the central portion of the basin, the seam is flat-lying or very gently undulating. On the north side of the basin it has a southeasterly dip which gradually increases from 50 feet to the mile, to a maximum of 150 feet to the mile on the northern rim. The southern rim of the basin has a dip to the northwest towards the centre of the basin but the dip is less pronounced seldom exceeding 100 feet to the mile. Over much of the area the overlying bedrock and a considerable part of the coal seam have been removed by pre-glacial erosion, the extent of which is difficult to determine due to the cover of subsequent glacial drift. As a result of the basin-like structure of the field and the pre-glacial erosion, glacial deposition and subsequent post-glacial erosion that have taken place, the coal seam is now found at varying depths, ranging from surface outcrops to a maximum of 170 feet. In about a third of the coal field the coal seam lies within 20 to 50 feet of the surface, whereas over the remaining two-thirds of the area it has a cover of from 50 to 170 feet. The seam ranges in elevation from below the summer level of Grand Lake which is 4 feet above sea level, to a maximum height of about 260 feet above sea level.

Coal mined in the Minto area is classified as high volatile "A" bituminous. In rank, it is comparable to the coals of Nova Scotia. In grade, however, it is inferior due to excessive impurities and its physical characteristics. It contains an appreciable quantity of visible pyrite and the ash and sulphur contents in run-of-mine coal range from 15 to 25 per cent and 5 to 9 per cent respectively.



MINTO COALFIELD
(GRAND LAKE COAL BASIN)

Calorific values range from 11,000 to 12,000 with an average of 11,600 B.t.u./lb. Analyses of coals produced by three of the principal collieries in the Minto field are as follows:

ANALYSIS OF MINE RUN SAMPLES (AS RECEIVED BASIS)

—	Minto Coal Co.	Percentage of Total N.B. Prod. 1944	Miramichi Lumber Co.	Percentage of Total N.B. Prod. 1944	Avon Coal Co. Ltd.	Percentage of Total N.B. Prod. 1944
Proximate Analysis........	....	33.53	....	11.70	....	13.75
Moisture......Per cent	3.0		3.0		3.0	
Ash............Per cent	17.2		18.5		16.9	
Volatile Matter......Per cent	30.2		29.7		30.2	
Fixed Carbon..Per cent	49.6		49.8		49.9	
Calorific Value...B.t.u./lb.	11,950		11,830		11,950	
Sulphur..........Per cent	7.2		6.6		7.7	
F.P.A........... °F.	2,040		2,200		2,030	

The coal is strongly coking but its high sulphur and ash content make it unsatisfactory for the production of commercial coke. The coal is highly fractured and breaks down readily on handling, mining and cleaning operations resulting normally in a run-of-mine coal of about 66 per cent of 1½ inch slack. This, in conjunction with the high sulphur content, makes the coal subject to spontaneous combustion when stock-piled.

As will be readily appreciated from the foregoing description, the fundamental geological factor in respect to the development of the Minto field is the extreme thinness of the coal seam and its inferior quality.

The secondary geological factors which bear upon the development of the field are:

(1) Pre-glacial erosion of the coal measures and the weathering of the exposed coal.
(2) Glacial erosion and deposition and post-glacial stream erosion.
(3) The inclination of the coal seam and its minor undulations.
(4) The porous nature of the sediments associated with the coal seam.
(5) The low level of the coal basin and general low relief of the area.

Pre-glacial erosion appears not only to have removed the Grand Lake coal-bearing formation from extensive areas in the province outside of the Minto basin, but has dissected the basin itself so that now in effect it consists of several deposits rather than one. The field thus consists of one relatively large central area with detached smaller areas on the east, south and west, separated from it by the main watercourses and barren areas from which the coal has been eroded. Where coal seams were exposed by pre-glacial erosion they were subjected to deterioration by weathering, and in places this erosion reduced the thickness of the seam to only a few inches.

Glacial activity resulted in a further removal of the weathered coal where the seams were exposed, and over most of the area has concealed the seams or bedrock by a thick blanket of drift, filling completely some of the pre-glacial valleys from which the coal has been removed, so that the boundaries of the productive areas can only be determined by development and extensive systematic drilling.

This problem has been accentuated by the post-glacial erosion of the existing watercourses which have excavated new channels through the coal-bearing formation, and have exposed the coal seam along their valleys. The presence of these exposures is apt to suggest the existence of an extended coal deposit, whereas investigations have later shown that this coal had been removed by adjacent pre-glacial channels the existence of which was not suspected due to the blanket of glacial drift.

This blanket, which conceals the bedrock over much of the area, consists mainly of unconsolidated ground-up rock and clay largely impervious to water. Where it directly overlies the seam it has protected the coal from weathering. It seldom exceeds 30 feet in thickness and again where it immediately covers the coal it provides from the point of view of depth of cover and ease of its removal favourable conditions for open-cut mining. However the nature of the glacial drift also raises problems in respect to these operations. Unlike the bedrock, due to its unconsolidated character it readily slumps into the open-cuts, especially where the drift exceeds 25 feet in thickness. Again the impervious nature of the boulder clay tends to retain surface water in the excavations and to restrict the seepage of this water to the bedding plane of the coal seam, with the result that it not only retards operations on the site, but interferes with operations down the dip of the seam.

The last three geological factors listed above are of special significance in respect to drainage problems generally. The nature of the coal measures and the basin-like structure of the deposit permit the surface water which enters at the outcrop, or seeps down the joint planes of the overlying sediments, to percolate down the bedding planes of the coal seam. The entry of water at the outcrop is particularly important in areas where the coal deposit has been cut by water courses and extends beneath the level of Grand Lake.

The concentration of water becomes of increasing importance in regard to the development of the deposit down the dip of the seam and reaches serious proportion in the centre of the basin where the intake is from all directions. Disposal of water throughout most of the Minto coal basin is difficult owing to the low relief of the area generally. In respect to the centre of the basin where the accumulation is greatest, the problem is accentuated by the fact that the coal seam lies well below the level of Grand Lake and its several inlets.

According to the provincial Department of Mines, the Minto coal field in 1943 had reserves amounting to 69,474,900 tons of recoverable coal with a further possible reserve of 8,809,400 tons.

The estimate prepared for the Commission, details of which appear in Table 8, Appendix A, places the reserves of recoverable coal at 45,000,000 short tons with a possible additional 6,000,000 tons. The coal operators in the Minto field consider the reserves should be placed between 18 and 25 million tons of recoverable coal as extraction of the coal in some areas is problematical.

The Commission is advised that about one-third of the above reserves, or about 15 million tons, are available for recovery by stripping operations, but that underground operations will continue to be of primary importance in the field. The figures suggest that the reserves are sufficient to last for at least 75 years on the basis of maximum annual production to date.

PROVINCE OF ONTARIO

There are no deposits of coal of any immediate commercial significance in the Province of Ontario. The presence of a poor quality lignite in northern Ontario in the region south of James Bay has been known to Indians and Traders for a long time and these deposits have been examined periodically by the Geological Survey since 1871.

The most important of these deposits outcrops at Blacksmith Rapids on Abitibi River, 70 miles up-stream from James Bay. This deposit has its maximum development some 2 miles west of the outcrop near Onakawana River and for this reason has been called the Onakawana field.