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Coal Fields and Coal Resources of Canada

BY

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CONTENTS.

CHAPTER III.

CHAPTER IV.

CHAPTER V.

CHAPTER VI.

CHAPTER VII.

CHAPTER VIII.

CHAPTER IX.

PAGE

ILLUSTRATIONS.

Preface.

The following report on the coal-fields and coal resources of Canada, is reprinted, with some additions, from "The Coal Resources of the World," a collection of official reports from many countries compiled at the request of the Executive Committee of the Twelfth International Geological Congress.

As the classification of coal in use in the various countries is not uniform, a general classification based on physical and chemical properties was proposed. This was generally adhered to, and in the tables of the present report the classification refers to that adopted for the Geological Congress publication. This procedure was necessary in order that a proper comparison and compilation could be made. To interpret the various classes, it is necessary to repeat the classification adopted, as below:—

CLASSIFICATION OF COAL ADOPTED IN REPORT.

Class A.

(1.) Burns with short, blue flame; gives off 3 to 5 per cent of volatile combustible matter.

Fuel ratio: $\frac{\text{Fixed carbon}}{\text{Volatile matter}} = 12$ and over.

Calorific value, 8,000 to 8,330 calories, or, 14,500 to 15,000 B. T. U.

Mean composition,

Carbon	93 to 95%
Hydrogen	2 to 4
Oxygen and nitrogen	3 to 5

(2.) Burns with slightly luminous, short flame and little smoke; does not coke and yields from 7 to 12 per cent of volatile matter.

Fuel ratio, 7 to 12.

Calorific value generally 8,330 to 8,600 calories, or, 15,000 to 15,500 B.T.U.

Mean composition,

Carbon	90 to 93%
Hydrogen	4 to 4·5
Oxygen and nitrogen	3 to 5·5

Class B.

(1.) Burns with short, luminous flame and yields 12 to 15 per cent volatile matter; does not readily coke. Fuel ratio, 4 to 7.

Calorific value generally 8,400 to 8,900 calories, or, 15,200 to 16,000 B.T.U.

Mean composition,

Carbon	80 to 90%
Hydrogen	4·5 to 5
Oxygen and nitrogen	5·5 to 12

(2.) Burns with luminous flame and yields from 12 to 26 per cent volatile matter; generally cokes.

Fuel ratio, 1·2 to 7.

Calorific value 7,700 to 8,800 calories, or, 14,000 to 16,000 B.T.U.

Mean composition,

Carbon	75 to 90%
Hydrogen	4·5 to 5·5
Oxygen and nitrogen	6 to 15

(3.) Burns freely with long flame; withstands weathering but fractures readily and occasionally has moisture content up to 6 per cent; volatile matter up to 35 per cent; makes porous, tender coke.

$$\frac{\text{Fixed carbon} + \frac{1}{2}\text{ volatile}}{\text{Hygroscopic moisture} + \frac{1}{2}\text{ volatile}} = 2\cdot5 \text{ to } 3\cdot3.$$

Calorific value 6,600 to 7,800 calories, or, 12,000 to 14,000 B.T.U.

Mean composition,

Carbon	70 to 80%
Hydrogen	4·5 to 6
Oxygen and nitrogen	18 to 20

Class C.

Burns with long, smoky flame; yields from 30 to 40 per cent volatile matter on distillation, leaving very porous coke. Fracture generally resinous.

Calorific value 6,600 to 8,800 calories, or, 12,000 to 16,000 B.T.U.

Class D.

Contains generally over 6 per cent of moisture; disintegrates on drying; streak brown or yellow; cleavage indistinct.

(1.) Moisture in fresh-mined, commercial output, up to 20 per cent. Fracture generally conchoidal.

Drying-cracks irregular, curved lines.

Colour generally lustrous black, occasionally brown.

$$\frac{\text{Fixed carbon} + \frac{1}{2}\text{ volatile}}{\text{Hygroscopic moisture} + \frac{1}{2}\text{ volatile}} = 1{\cdot}8 \text{ to } 2{\cdot}5.$$

Calorific value 5,500 to 7,200 calories, or, 10,000 to 13,000 B.T.U.

Average composition,

Carbon	60 to 75%
Hydrogen	6 to 6·5
Oxygen and nitrogen	20 to 30

(2.) Moisture in commercial output over 20 per cent. Fracture generally earthy and dull.

Drying-cracks generally separate along bedding planes and often show fibrous (woody) structure.

Colour generally brown, sometimes black.

Calorific value 4,000 to 6,000 calories, or, 7,000 to 11,000 B.T.U.

Average composition,

Carbon	45 to 65%
Hydrogen	6 to 6·8
Oxygen and nitrogen	30 to 45

In the above classification, letters are substituted for names. In a general way the classification conforms to the nomenclature used in America, as follows:—

A_1 = Anthracite coal.
A_2 = Semi-anthracite coal.
B_1 = Anthracitic coal and high carbon bituminous coal.
B_2 = Bituminous coal.
B_3 = Low carbon bituminous coal.
C = Cannel coal.
D_1 = Lignitic or sub-bituminous coal.
D_2 = Lignite.

Coal Fields and Coal Resources of Canada.

(See Map 125A in pocket.)

CHAPTER I.

INTRODUCTION.

The British Empire is now known to be possessed of very large reserves in coal. In the estimates only lately made, its share is very nearly one-quarter of the world's reserve. As over one-half of the world's supply is estimated to be in territory owned by the United States of America, the present known supply for all the remaining nations is about equal to that of the British Empire.

The coal reserve of the various portions of the Empire are given in the following table.

	Anthracitic coals.	Bituminous coals.	Sub-bituminous coals, brown-coals and lignites.	Totals.
	Million tons.	Million tons.	Million tons.	Million tons.
Canada	2,158	283,661	948,450	1,234,269
Great Britain and Ireland	11,359	178,176	.....	189,533
Australia	659	132,250	32,663	165,572
India	.....	76,399	2,602	79,001
South Africa	11,660	44,540	.....	56,200
New Zealand	.....	911	2,475	3,386
Rhodesia	2	493	74	569
Newfoundland	.....	500	.....	500
Southern Nigeria	.....	.....	80	80
British N. Borneo	.....	75	.....	75
	25,838	717,005	986,344	1,729,185

Canada appears to be an important storehouse, but although it has large reserves, much of this is not available for the commerce of the Empire. Important supplies are, however, to be found on both the Atlantic and Pacific seaboards and may compete with foreign fuels.

Any review of the coal-fields of Canada must be considered as tentative in character, since a large part of the country, particularly in the northwest, has not been examined in detail, and even in the better known fields the information available is not full, for in many of them mining operations, with the closer examinations they entail, have not been prosecuted for any great length of time. Large areas in Saskatchewan and Alberta are classed as coal-fields in this paper and on the accompanying map since, within the outlines indicated, the formations underlying them are those which, in neighbouring areas, are known to carry seams of lignite, sub-bituminous, and bituminous coals. The information relating to these areas has been obtained mainly from the study of the actual rock outcrop; but it is being supplemented, with the increase in settlement, by information obtained from borings.

CANADIAN COAL DEPOSITS CLASSIFIED ACCORDING TO AGE.

Interglacial.

With the exception of peat deposits, which are still in process of formation, the youngest material that can be classed with the lignites and coals are lignitic beds that were formed during an interglacial, warm period, in the southern part of the Hudson Bay basin and in East Kootenay, British Columbia. These were entombed by the till of a later glacial invasion and now form lignites of poor quality.

Tertiary.

Many small areas of Tertiary sediments in British Columbia, Yukon, and the Arctic islands, the deposits of fresh-water lakes,

contain mineable lignite and sub-bituminous coals. In Alberta and Saskatchewan coal is found in strata that represent the lower portion of the Tertiary.

Upper Cretaceous.

Large areas in Alberta and southern Saskatchewan show sand and clay deposits, with coal-seams, which were laid down about the close of the Cretaceous period or the beginning of the Tertiary, when these areas were at an elevation not far above sea-level.

The coals of Vancouver island and those of the plains in the vicinity of Lethbridge occur in the upper beds of the Cretaceous.

Lower Cretaceous.

The bituminous coals and anthracite of the Rocky mountains and Queen Charlotte islands and those of many areas in the interior of British Columbia and Yukon are of Lower Cretaceous age, and occur near the base of that formation.

Carboniferous.

The Coal Measures, a series of beds, mainly littoral in character, which overlie the marine beds of the Carboniferous, form the principal coal-fields of Nova Scotia. The upper measures, forming the top of the Upper Carboniferous, which are generally mapped as Permo-Carboniferous, contain only few beds of coal. The "Millstone Grit," a basal series conformably underlying the Coal Measures, contains a few thin seams which become of economic importance only where the true Coal Measures are absent, as in the case of New Brunswick.

Lower Carboniferous or Devonian.

In parts of Nova Scotia plant remains occur in a series of sandstones and shales underlying the Carboniferous limestone,

but no mineable coal seams are known. The most important deposits credited to this age are the cannel and oil-shales of the Arctic islands. At Lepreau, in New Brunswick, shales that are possibly of Devonian age contain carbonaceous matter resembling anthracite.

DISTRIBUTION AND USES OF CANADIAN COALS.

Canada has large supplies of bituminous and sub-bituminous coals, situated for the most part in the western interior, but there are also important fields on both coasts.

On the Atlantic seaboard bituminous coals are extensively mined and are used in general power production, for manufacturing and railway and marine transportation, as well as in the reduction of iron ore. On the Pacific coast the bituminous coals are mined for power production and for export.

The interior fields supply coals of various grades, the coals of the mountainous region of eastern British Columbia and western Alberta being the most important and of the highest grade.

In Manitoba and southern Saskatchewan the coal-fields supply coals, lignitic in character, that are well adapted to domestic use. The extensive coal-fields of Alberta, which contain coals of a wide range of character, form Canada's greatest coal reserve. The interior portion of British Columbia has many coal-areas that will be of value in providing coking coal for the smelting of the ores for which the province is famous. The fuels of the Arctic islands may, probably, be mined in the future, like the Spitzbergen coals, which lie in about the same latitude.

The coal areas of the different provinces are outlined on the map of Canada, where some indication of the variety in character of the coal is also shown. An estimate of the total reserve for each province is given in the following table.

SUMMARY OF ESTIMATE OF COAL RESOURCES OF CANADA.

The following tables contain summarized estimates of the coal resources of Canada.

GROUP I.

INCLUDING SEAMS OF 1 FOOT OR OVER, TO A DEPTH OF 4,000 FEET.

DISTRICT.	ACTUAL RESERVE (Calculation based on actual thickness and extent).			PROBABLE RESERVES (Approximate estimate).		
	Area square miles.	Class of coal. †	Metric tons.	Area square miles.	Class of coal. †	Metric tons.
Nova Scotia	174·31	B_2	2,137,736,000	273·5	B_2	4,871,817,000
		C	50,415,000	.....	C	20,000,000
New Brunswick	.....	.....	.....	121·0	B_2	151,000,000
Ontario	.....	.....	.....	10·0	D_2	25,000,000
Manitoba	.....	.....	.....	48·0	D_2	160,000,000
Saskatchewan	306·0	D_2	2,412,000,000	13,100·0	D_2	57,400,000,000
Alberta	25,300·0	D_2	.....	56,375·0	D_2	26,450,000,000
		D_1	382,500,000,000		D_1	464,821,000,000
		B_2	1,197,000,000		B_2	139,161,000,000
		B_2B_1	2,026,800,000		B_2B_1	43,022,600,000
		A_2	669,000,000		A_2	100,000,000
		A_2B_2	23,653,242,000		A_2B_2	40,807,700,000
British Columbia	439·0	B_2	118,000,000	5,595·0	B_2	2,300,000,000
		D_2	60,000,000		D_1D_2	5,136,000,000
					C	1,800,000,000
Yukon	.....	.....	.....	2,840·0	A_2B_2	250,000,000
					D_1D_2	4,690,000,000
North West Territories	.....	.....	.....	300·0	D_2	4,800,000,000
Arctic islands	.....	.....	.....	6,000·0	B_2B_2C	6,000,000,000
Totals	26,219·31	.....	414,804,193,000*	82,662·5	.....	801,966,117,000

* In this total 20,000,000 has been deducted for the amount of coal of all classes already extracted in Alberta.
† For classification of coal see Preface.

GROUP II.

INCLUDING SEAMS OF 2 FEET AND OVER AT DEPTHS BETWEEN 4,000 AND 6,000 FEET.

DISTRICT.	PROBABLE RESERVES (Approximate estimate).		
	Area square miles.	Class of coal.	Metric tons.
Nova Scotia (marine areas, 3 to 5 mile limit)	73	B_2	2,639,000,000
Alberta	203	B_2	12,700,000,000
British Columbia	11	B_2	2,160,000,000
Totals	287		17,499,000,000

TOTALS BY PROVINCES—GROUPS I AND II.

Nova Scotia	9,718,968,000	metric tons
New Brunswick	151,000,000	"
Ontario	25,000,000	"
Manitoba	160,000,000	"
Saskatchewan	59,812,000,000	"
Alberta	1,072,627,400,000	"
British Columbia	76,034,942,000	"
Yukon	4,940,000,000	"
North West Territories	4,800,000,000	"
Arctic islands	6,000,000,000	"
	1,234,269,310,000	

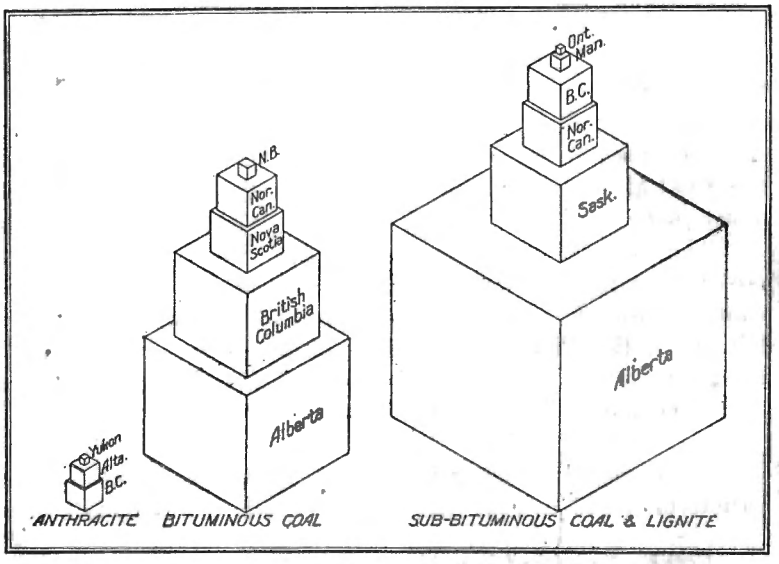

Figure 1. Diagram showing distribution of Canadian coal.

CHAPTER II.

NOVA SCOTIA.

INTRODUCTORY.

(See Map 126A in pocket.)

The measures in which coal is found in this province range in age from Lower Carboniferous[1] to, possibly, Permian. Numerous thin streaks made up of the remains of plant life, and forming, in places, small coal-seams, occur beneath the Carboniferous limestone, but all the richer deposits are above the limestone, in strata generally considered to be of the same age as the Coal Measures of Great Britain. These overlie a series of basal beds of coarser material known in Canada as the "Millstone Grit," though they are merely lower measures in which a few small coal-seams are sometimes found. The series overlying the Coal Measures are very similar to the Millstone Grit in many places and also are coal-bearing to a very limited extent.

The Coal Measures proper are exposed in five areas in the province, with important collieries operating in each: the Cumberland coal-field, which includes the Joggins and Springhill areas; the Pictou coal-fields; the Inverness (mainly submarine); and the Cape Breton or Sydney coal-fields, containing both land and submarine mining areas.

An estimate of the amount of coal to be found in the various fields of Nova Scotia is compiled in the following tables:—

[1] Coal has been found in rocks mapped as Devonian. The fossil plants have a Carboniferous facies and the age is here assigned to the Lower Carboniferous.

Coal Resources of Nova Scotia.

GROUP I.

Including Seams of 1 Foot or Over, to a Depth of 4,000 Feet.

District.	Coal-Seams.		Actual Reserve (Calculation based on actual thickness and extent).			Probable Reserves (Approximate estimate).		
	No.	Thickness.	Area square miles.	† Class of coal.	Metric tons.	Area square miles.	† Class of coal.	Metric tons.
Cumberland county	....	.....	60	B_2	682,000,000	5	B_2	250,000,000
Colchester	....	.....	.....	.....	.....	1	B_2	1,000,000
Pictou	....	.....	11	B_2	345,440,000	8	B_2	450,000,000
				C	45,000,000			
Antigonish	....	.....	.....	.....	.....	1	C	20,000,000
Richmond	2	3 to 5 feet	.....	.....	.....	4	B_2	12,360,000
Inverness (Land area)	....	.....	5·75	B_2	61,800,000	10	B_2	22,000,000
Inverness (Submarine area)	....	.....	4	B_2	86,000,000	7	B_2	73,000,000
Cape Breton county, land area	....	.....	92·66	B_2	1,022,496,000	.....	.....	.....
				C	5,415,000	.....	.....	.....
Marine, 3 mile limit	....	.....	.....	.....	.....	168·5	B_2	4,063,457,000
Totals	....	.....	74·31	.....	2,248,151,000	273·5	.....	4,891,817,000
Less amount mined	....	.....	.....	.....	60,000,000	.....	.....	.....
					2,188,151,000			

† For classification of coal see Preface.

GROUP II.

INCLUDING SEAMS OF 2 FEET AND OVER, AT DEPTHS BETWEEN 4,000 AND 6,000 FEET.

DISTRICT.	PROBABLE RESERVES (Approximate estimate).		
	Area.	Class of coal.	Metric tons.
Cape Breton county—Marine, 3 to 5 miles.....	73 square miles.	B_2	2,639,000,000

CUMBERLAND COUNTY.

In the eastern part of Cumberland county the Permian and Upper Carboniferous rocks conceal any Coal Measures that may occur. Exposures of Millstone Grit, liable to contain thin coal-seams, are found forming a band from near Springhill to Wallace harbour on Northumberland strait. The west end of the band is synclinal in form and an arm extending east is found to contain a seam of coaly shale. The tongue of Permian rocks in the middle of this syncline may conceal Coal Measures. At South Victoria, which is on the outcrop of the Millstone Grit on the north side of the syncline, small coal-seams have been found just under conglomerates belonging to the newer formation; they are not economically valuable. Similar conditions at the southern limit of the syncline are found at Atkinson Siding on the Intercolonial railway. At the western end, somewhat nearer the middle of the syncline, small seams have been found about half a mile east of Oxford station. The thickness of the upper seam was 15 inches; 4½ feet below this a dirty seam of 2 feet 6 inches occurs.

A small outlier of the Lower Carboniferous rocks at Parrsboro on Minas basin evidently includes somewhat higher beds, since small coal-seams have been found near the coast.

Two areas in which Coal Measures are exposed occur in the county, and are of great economic importance. One, extending from Chignecto bay eastward to the middle of the county, contains southerly-dipping beds (probably the northern limb of a syncline). The Coal Measures, although highly inclined, are not otherwise much disturbed and are mined at several points. The second field lies south and east of the first and is supposed to be a continuation of the beds of the northern field, brought up by a deformation of the syncline, including faulting, folding, and a local uplift.

JOGGINS COAL-FIELD.

The Coal Measures of the Joggins field form a narrow band in which coal-seams have been traced for 22 miles. The thickness of the seams at the several mines situated along the Joggins railway is as follows:—

South Joggins Colliery. The thickest seam has: 3 feet 6 inches coal, 1 foot 6 inches shale, 1 foot 6 inches coal. The measures dip at an angle of 19 degrees.

Strathcona Colliery. Two seams are mined. The upper seam has about 42 inches coal; the second seam, 500 feet beneath it, has from 27 inches to 30 inches coal, with a parting of from 8 inches to 12 inches.

Minudie Colliery. The seam has: top coal 18 inches, clay parting 6 inches to 24 inches, bottom coal 10 inches.

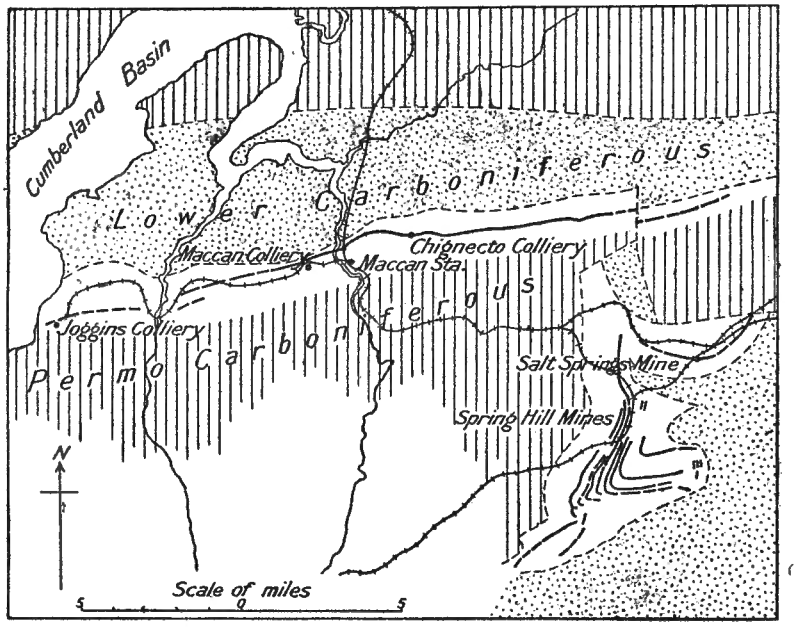

Figure 2. Coal-fields of Cumberland county.

Jubilee Mine. The seam mined has 20 inches to 24 inches of coal.

Maccan Colliery. A section[1] of the seam measured on the 30 degree slope which cuts measures dipping at 50 degrees, shows:—

[1]The sections have been taken from "An Economic Investigation of the Coals of Canada," by J. B. Porter and R. J. Durley, Dept. of Mines, Canada, Mines Branch, Vol. I, Part II, by Theo. Denis, pp. 50-59.

Coal.....1 foot 10 inches.
Shale.....3 inches.
Coal.....6 inches.
Shale.....3 inches.
Coal.....1 foot 6 inches.
Shale.....4 inches
Coal.....1 foot 5 inches.
Shale.....3 inches.
Coal.....4 feet.
Shale.....1 foot.
Coal.....1 foot 3 inches.

Chignecto Colliery. The seam has: top coal, 3 feet; parting, 1 foot 6 inches; middle coal, 1 foot 6 inches; parting, 5 inches; lower coal, 6 inches. Dip of seam 38 degrees.

Styles Mine. A section of the seam shows: coal, 2 feet; clay and shale, 7 inches; coal, 1 foot 1 inch. The dip is 42 degrees, flattening slightly with depth.

The measures contain a great number of small seams and a few seams of workable size, including two on Chignecto bay, which have sufficient coal to be considered in estimating the reserve. The measures dip to the south to form a synclinal basin, the southern edge of which rests on older rocks which, at the time of the deposition of the measures, formed a prominent ridge. Whether the Coal Measures reach as far south as do the covering rocks, is not known, but it is probable that a concealed field extends to the south of the Joggins field, and judging by the number and thickness of seams in the Springhill area, the Joggins seams should thicken toward the middle of the basin.

SPRINGHILL AREA.

The measures exposed at Springhill were deposited nearer the middle of the original basin than were those in the Joggins area. As the number and thickness of the seams are greater here, it is thought that there must be a large body of coal between Springhill and Chignecto bay, though it may lie at great depth.

At Springhill there are three main areas separated by faults, viz.: (1) the Saltspring, (2) the Springhill, and (3) the Mapleton.

(1.) *Saltspring.* In this area a broad synclinal block of Coal Measures and Lower Carboniferous limestones, dipping northward, is cut off by an east and west fault. Two small seams, 1 foot and 2½ feet in thickness, are exposed on Black river. The upper one has been traced by bore-holes to the fault line to the northeast and for 1½ miles westward—a total distance of 3¾ miles. The seam does not thicken along the outcrop and probably does not average over 2 feet.

(2.) *Springhill.* The most important reserve of coal in the area is found at Springhill. The measures appear to represent the deposits of the central part of the basin of deposition brought to the surface by folding and local elevation. They dip steeply westward toward the concealed field south of the Joggins area and contain five mineable seams besides a few small ones. The section[1] shown in the mine workings gives a total thickness of 49 feet of coal disposed as follows:—

Coal, North seam	13	feet	0	inches
Measures	105	"	0	"
Coal	5	"	0	"
Measures	130	"	0	"
Coal	2	"	4	"
Measures	185	"	0	"
Coal, Main or East slope seam	11	"	0	"
Measures	80	"	0	"
Coal, Black or West slope seam	11	"	0	"
Measures	100	"	0	"
Coal	4	"	0	"
Measures	176	"	0	"
Coal	2	"	9	"

(3.) *Mapleton.* No mining has been done in the Mapleton area which adjoins the Springhill area to the south, and little

[1]The sections have been taken from "An Economic Investigation of the Coals of Canada," by J. B. Porter and R. J. Durley, Dept. of Mines, Canada, Mines Branch, Vol. I, Part II, by Theo. Denis, pp. 50-59.

information is available regarding it. Judging from the thinning of the Springhill seams toward the south, it seems probable that the Mapleton beds were deposited near the margin of the original basin of deposition and that the beds are, therefore, thin.

SUMMARY OF INVESTIGATIONS BY THE DEPARTMENT OF MINES OF COALS SUPPLIED IN COMMERCIAL SAMPLES BY MINES IN CUMBERLAND COUNTY, N. S. COAL IS SCREENED AND HAND PICKED.[1]

Analyses.

LOCALITY.	MOISTURE.		PROXIMATE ANALYSIS OF DRY COAL.			ULTIMATE ANALYSIS OF DRY COAL.					
	Mine.	Air-dried.	Vol.	F.C.	Ash.	C.	H.	S.	N.	O.	B.T.U. Dried coal.
	%	%	%	%	%	%	%	%	%	%	
Joggins colliery	1·3	0·6	36·6	44·8	18·6	63·5	4·1	5·4	1·3	7·1	11,590
Minudie colliery	3·8	2·8	35·7	48·8	15·5	64·8	4·4	6·7	1·1	7·5	11,830
Chignecto colliery	3·6	3·2	41·0	45·7	13·3	66·2	4·8	6·4	1·3	8·0	12,150
Springhill—											
No. 1 colliery	2·2	.....	33·3	63·3	3·4	81·5	5·1	1·0	1·9	7·1	14,190
No. 2 colliery	2·8	2·0	32·3	58·5	9·2	75·1	4·9	1·6	1·2	8·0	13,370
No. 3 colliery	2·8	2·3	33·5	55·0	11·5	73·1	4·6	1·8	1·8	7·2	13,000

[1] From "An Investigation of the Coals of Canada," Mines Branch, Dept. of Mines—No. 83.

Boiler Tests.

	Cal. value per lb. of coal as fired. B.T.U.	Moisture in coal as fired. %	Ash and clinker from dry coal. %	Equivalent evaporation per lb. as fired.
Joggins colliery, raw	11,250	2·9	14·8	5·66
" " washed	12,250	3·8	8·2	6·22
Minudie colliery, raw	11,500	2·8	12·2	5·61
" " washed	12,160	3·5	12·7	6·09
Chignecto colliery, raw	11,790	3·0	11·2	5·82
" " washed	12,210	5·3	7·3	6·31
Springhill—				
No. 2 colliery, raw	13,120	1·9	7·9	6·63
" " washed	13,330	3·8	5·6	7·36
No. 3 " raw	12,710	2·2	8·8	6·18
" " washed	13,110	3·4	8·1	7·20

Coking Tests.

Source of Coal.	Age of sample in months.	Type of oven.	Time of coking in hours.	Remarks.	Class of coke.
Joggins colliery.....	21½	Bernard at Sydney.....	48	Dirty, weak coke, no regular fracture; makes a lot of breeze.	B
" "	1	" " "	48	Dull black coke, harder and makes less breeze than former sample.	+B
Minudie colliery....	21	Otto-Hoffman at Sydney.....	48	Soft and friable, had scarcely coked.	—B
Chignecto colliery..	21	" " "	48	Very irregular coke, in parts reasonably hard; in other parts very friable.	+B
Springhill—					
No. 1 colliery....	½	" " "	40	Good hard coke, very regular fracture, breaks up into small pieces, but no breeze.	A
" 2 "	21½	" " "	40	Medium good coke, not very strong.	+B
" 2 "	½	" " "	40	Medium coke, fairly strong, breaks into curved rods.	—A
" 3 "	21½	" " "	40	Fair coke, but not very strong.	+B
" 3 "	21½	Beehive at Bridgeport.....	72	Not a commercial coke.	
" 3 "	½	Otto-Hoffman at Sydney.....	40	Excellent coke, regular slightly curved cleavage.	—A

A=Good commercial coke—subdivided +A, A, —A.
B=Poor commercial coke—subdivided +B, B, —B.
C=An agglomerate, not commercial coke—subdivided +C, C, —C

Gas Producer Tests.

DESCRIPTION.	Joggins colliery, Canada, Coal and Ry. Co., Joggins, N. S.	No. 2 colliery, Cumberland Ry. and Coal Co., Springhill, N. S.
Volatile matter %	34·4	31·4
Ash %	18·1	7·3
Moisture %	2·5	1·9
Cal. value of coal as charged B.T.U.	11,300	13,120
Cal. value of gas (lower) per cub. ft. B.T.U.	98·9	93·8
Producer efficiency	0·486	0·438
Coal per B.H.P. per hr. lbs.	2·11	2·07
Caking of coal	No trouble.	No trouble.
Average interval between poking	1 hr., 30 min.	1 hour.
Clinker	No trouble.	No trouble.
Tar	41 lbs.	34 lbs.
Uniformity in gas quality	Variable.	Rather variable.
Amount of steam used	Moderate.	Moderate.
Combustible in refuse	"	"
Remarks	Gave poor gas, but worked well in producer.	Gave poor gas but easily worked in producer.

SUMMARY OF COAL RESOURCES, CUMBERLAND COUNTY.

GROUP I.

INCLUDING SEAMS OF 1 FOOT OR OVER, TO A DEPTH OF 4,000 FEET.

DISTRICT.	COAL-SEAMS.		ACTUAL RESERVE (Calculation based on actual thickness and extent).			PROBABLE RESERVES (Approximate estimate).			POSSIBLE RESERVE.
	No.	Thickness.	Area square miles.	Class of coal.	Metric tons.	Area square miles.	Class of coal.	Metric tons.	
Joggins area	2	3 to 5 ft.	44	B_2†	220,000,000	.....	.....	.....	.....
South edge of syncline	....	.....	.....	.....	.....	.....	.....	.....	Large.
Springhill	7	Aggregate 49 ft.	9	B_2	454,000,000	5	B_2	250,000,000	.....
Saltspring	1	Aggregate 2 ft.	7	B_2	8,000,000	.....	.....	.....	.....
Totals	....	.....	60	.....	682,000,000	5	.....	250,000,000	.....

† Bituminous coal.

COLCHESTER COUNTY.

The Riversdale series outcrops north of Truro from beneath Triassic rocks, and in several places contains small seams of coal which are exposed at a point near Kempton on Salmon river, on two branches of North river, and at other places.

Overlying the Riversdale series and west of the areas mentioned, conglomerates, supposed to be of Lower Carboniferous age, contain a few small seams of coal. The exposures are found mainly in the channels of streams flowing south to Cobequid bay. On Debert river, east of Londonderry, a seam from 3 feet to 3½ feet in thickness is reported. South of Truro, on Stewiacke river, a few small coal-seams occur in what is mapped as the Windsor series of the Lower Carboniferous.

HANTS COUNTY.

South of Kennetcook Corner a few small coal-seams are found in banded shales, underlying sandstones and resembling the Horton and Gaspereau shales. The sandstones are overlain by limestone containing gypsum. Very thin coal-seams are found, in the so-called Devonian, in the northeast corner of the county on Rocky brook, a branch of Salmon brook.

PICTOU COUNTY.

The Millstone Grit contains a few thin coal-seams. A seam on Merigonish island, east of Pictou, is 1 foot 6 inches in thickness and may at some future period be utilized. The Coal Measures proper are found in two adjacent fault-blocks south of New Glasgow and form the principal coal-field of the county.

The Upper Carboniferous or Permian measures, lying nearly north of the coal-field, contain thin seams at a number of places, including New Glasgow, Tony river, Abercrombie point, and Big Caribou island. Coal-bearing Carboniferous measures may lie beneath these Permian beds, and drilling

operations have been intermittently undertaken with the object of proving their occurrence, especially in the area to the north of the Pictou coal-field, but up to the present without success.[1]

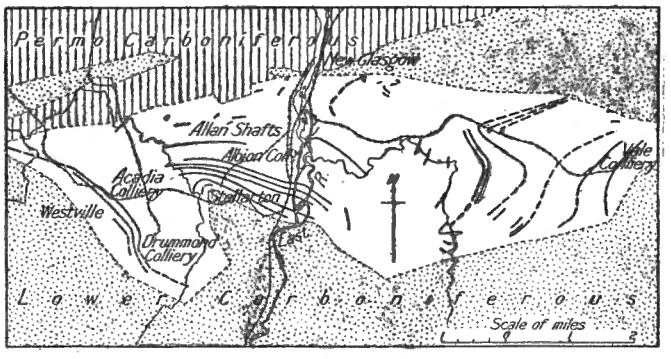

Figure 3. Pictou coal-field.

PICTOU COAL-FIELD.

The two fault-blocks forming this coal-field are separated by a fault that has a downthrow to the southwest of approximately 2,600 feet. The inclination of the fault-plane is to the northeast but the exact dip is not yet ascertained. Mining operations on seams in the western block have been carried past the surface trace of the fault. The western block forms the Westville coal-area. It is underlain by Millstone Grit and productive Coal Measures dipping about 20 degrees to the northeast. The seams in the lower part of the Coal Measures are supposed to be repeated in the block to the east, but they are not correlated with certainty, as the seams supposed to be the repeated ones are much thicker than those in the western block.

[1]Additional details of the Pictou fields and a bibliography are given in the following papers by H. S. Poole.

(1.) The Pictou Coal-Field, *Proc. N. S. Inst. Sc.*, Series 2, Vol. I, 1890-94, pp. 228-343.

(2.) The Coal-Fields of Pictou County, Annual Report, Geological Survey of Canada (New Series), Vol. XIV, 1901, Part M.

However, a general thickening of all the seams in that direction has been found in the mines, and there is little doubt of their repetition.

The Westville Area.

The seams in this area are as follows, in descending order:—

The Main seam has been traced from the Culton adit on McCulloch brook to Middle river, a distance of 3 miles. The thickness, as ascertained by surface drifts and in the mines, varies from 6 feet at the Culton adit to 9 feet 1 inch in workings half a mile to the northwest. At Drummond slope, the mine east of Westville, it varies from 8 to 18 feet. At 4,200 feet down the mine slope, it is 17 feet. In the Acadia colliery at Westville, it seems to have an average thickness of 15 feet, increasing in depth to 17 feet toward the southeast. Northwestward the seam thins out, and at French's tunnel it is less than 4 feet thick.

The Second seam is 184 to 260 feet below the Main seam, and has not been traced except in the vicinity of the mines, where it averages 12 feet. In a bore-hole at Westville it has a thickness of 16 feet 8 inches.

The Third seam lies 107 to 126 feet below the second seam. It is generally spoken of as the 6-foot seam. It is not mined here, so that little is known of its increase of thickness with depth, which, judging by its supposed continuation, does not begin until the Stellarton area is reached.

The Fourth seam lies 90 feet or less below the third seam. It shows 8 feet of inferior coal and probably decreases in thickness with depth, since the Purvis seam, at about the same horizon in the Stellarton area to the north, has less coal.

THE VALE AND STELLARTON AREAS.

The larger fault block of the Pictou coal-field extends from the McCulloch Brook fault, west of Stellarton, to Thorburn, and includes the Vale and Stellarton coal-areas. The measures contain two series of seams, an upper and a lower, separated

by about 1,600 feet of barren rock—mostly shale. The block is tilted toward the northeast and from the western part all the coal-seams of the upper series are eroded. The eastern end, containing the upper series, is bent to form a synclinal basin. The Lower Measures outcrop near Stellarton in a series of long curves, showing that the dip changes from a direction toward the axis of the Vale syncline at the east, to one toward the east and west syncline, which runs along the northern part of the area. An anticlinal fold, developed near the fault separating this block from the Westville one, suggests the occurrence of a corresponding syncline at the lower edge of the Westville block. The shales between the two coal horizons occupy a large tract in the middle of the area and also north of Stellarton. Oil-shales form the distinctive feature of the measures between the two coal horizons and these beds may at some future date be utilized.

The coal-seams in the eastern, or Vale, area are generally thicker on the eastern and northern edge of the basin. In the Stellarton, or Albion, area the thicker parts of the seams along the outcrop are near the mines, and all increase in thickness in the direction of the dip, and reach their maximum in the area mined near the Allan shafts.

THE VALE AREA.

The highest beds in the district occupy the middle of the basin and in the following descriptive sections they are referred to in descending order.

The Captain seam has been prospected near the Marsh pit in the northern basin, where it contains about 3 feet of coal. The seam probably underlies the greater part of the Marsh Pit basin, as well as a smaller basin to the south, where a 4-foot seam has been found.

Barren measures 22 feet 8 inches, containing one small seam of inferior coal.

The Millrace seam is of practically the same character as the overlying Captain seam; it shows 3 feet of coal in the Marsh pit, but less in the southern portion of the basin.

Barren measures, mostly clay and hard sandstone, 63 feet 6 inches.

The George Mackay seam has been traced more or less continuously on each side of the basin. At Marsh pit it contains 3 feet 9 inches of coal. Near the north fault the thickness diminishes to 2 feet 6 inches and to the south, as far as it has been traced, there seems to be about 3 feet of coal. Near the railway on the eastern outcrop there is 2 feet of good coal, and opposite Vale colliery the seam is 4 feet 6 inches with 2 feet of good coal.

Barren measures, 607 feet.

The Six Foot seam at the Vale colliery varies in thickness from 3 feet to 8 feet, though 6 feet is its general thickness in the outcrop on the east side of the basin. The western outcrop contains from 10 inches to 1 foot of coal. The diminution is shown in the workings to the west of the slope, which runs northeastward and is caused by the occurrence of lenticular masses of shale, next the roof.

Barren measures, about 700 feet, supposed to thicken to the westward and change in character to finer grained deposits.

The McBean or 8-foot seam is being mined at the Vale colliery. The outcrop is known definitely only on the eastern side of the basin, the margin of the deposit to the west being mostly concealed. A thickness of 8 feet 2 inches is found near the south corner of the area. At the colliery, the seam is 7 feet 6 inches thick and as far as traced northward an increase to 11 feet is noted. The question of how far westward the seam may be worked can only be surmised from the record in the slope at the Vale colliery, where, at 2,000 feet, the seam decreased from 7 feet 6 inches to 6 feet, and the outcrop to the west, just below the mouth of Marsh brook, of a 1-foot seam which may be a continuation of the McBean seam.

Thirty-seven feet beneath the McBean seam, a small coal-seam with a maximum thickness of 2 feet of coal has been found east of Thorburn, and several smaller seams are included in the next 304 feet.

The continuation of the section on McLellan brook from the mouth of Shale brook is as follows:[1]—

Black shale	20	feet	0	inches
Cannel	5	"	0	"
Purple and yellow sandstone	141	"	0	"
Shale	7	"	0	"
Cannel shale	4	"	6	"
Yellow sandstone	163	"	0	"
Oil-shale	29	"	0	"
Sandstone and shale	58	"	0	"
Sandstone	77	"	0	"
Shales	390	"	6	"

This section (although many small faults affect the strata near the mouth of McLellan brook) probably fills in the list of measures to the highest coal-seam in the Stellarton area. The cannel seams are very irregular and have not been exploited, so that an estimate of the amount of coal they contain is difficult. Their average aggregate thickness probably amounts to only a few feet.

THE STELLARTON AREA.

The seams, as noted before, increase in thickness toward the northeast and thin out to the east and west. They dip to the north and east and are mined mainly on the west side of East river. The seams, in descending order, are:—

A coal seam 3 feet 6 inches thick in the Stellarton area has been traced by outcrop for a short distance. It has 20 inches of good coal and probably forms a syncline to the north, but past this the ground is broken by faults.

Barren measures 1,126 feet.

The Main seam has been mined at several points, and is at present worked at the Albion colliery and Allan shafts. It dips to the north about 23 degrees and reaches the bottom of the syncline at the Allan shafts, a distance from the outcrop of three-quarters of a mile.

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[1]Annual Report, Geological Survey of Canada (New Series), Vol. XIV 1901, p. 21 M.

The seam diminishes in thickness along the outcrop from 34 feet 7 inches on Coal brook near the Albion mines, to 28 feet at the Pictou slopes east of East river, and to 6 feet 9 inches on the south side of a small fault in the McLeod pits. Westward it decreases to 22 feet or less at the Albion colliery. To the north it increases to 33 feet at the Foster pits and to 34 feet 6 inches in the Albion mine. In the Allan shafts its thickness is 45 feet.

Barren measures, 148 feet.

The Deep or Cage Pit seam varies considerably in thickness. The thickness at the outcrop on Coal creek is about 22 feet. From 1,800 feet down the slope on the Third seam, a cross-cut tunnel gives a section of 33 feet 6 inches. At the Allan shafts to the east the thickness is 20 feet.

Barren measures, with occasional lenses and small coal-seams, from 75 feet to 106 feet.

The Third seam where it outcrops near the mines on Coal brook, is 5 feet 9 inches thick, diminishing rapidly in thickness to the east and west. The increase of thickness with depth is shown in the mine slope, which, at a distance of 1,800 feet from the surface, gives a section of 14 feet 4 inches. It is generally considered as an 11-foot 9-inch seam.

Barren measures varying from 27 feet to 113 feet.

The Purvis seam shows 2 feet 6 inches of coal at the outcrop. In the McGregor pits there is a 4-foot seam that may represent the Purvis, but no direct correlation can be made. It is one of the thin seams that may be workable at some future time.

Barren measures, 77 feet to 145 feet, in some places containing small coal-seams.

The Fleming seam is 3 feet 3 inches thick at the outcrop, increasing to 9 feet 7 inches in the McGregor pits near the Albion mines. This is merely the top part of the McGregor seam.

The McGregor seam at the outcrop is 11 feet 7 inches thick. In the McGregor pits, the section is 14 feet 2 inches of coal. One thousand feet down the slope, the coal is 18 feet 9 inches in thickness. This seam has been traced from the McCulloch Brook fault to the railway at Stellarton.

The underlying measures, 211 feet thick, contain one 3-foot seam which has been traced from Stellarton to McCulloch brook, a distance of about 1 mile.

Stellar-Coal and Oil-Shale. A band which at one time was mined for the extraction of oil, averages 5 feet in thickness, but east of Coal brook seems to be only half that. In the lower measures of Stellarton the following section shows several coal-seams, but none of them have been traced and it is supposed that they are not persistent.

Seam A—Impure coal, 11 feet, decreasing eastward to 5 feet at old Stellar workings.

Measures	110	feet	6	inches
Seam B	2	"	0	"
Measures	75	"	0	"
Seam C	10	"	0	"
Measures	58	"	0	"
Seam D	0	"	6	"
Measures	35	"	0	"
Seam E	0	"	6	"
Measures	39	"	0	"
Seam F	4	"	0	"
Measures	9	"	0	"
Seam G	2	"	0	"

SUMMARY OF INVESTIGATIONS BY THE DEPARTMENT OF MINES OF COMMERCIAL SAMPLES OF COALS FROM PICTOU COAL FIELDS WHICH HAVE PASSED OVER A ¾-INCH SCREEN AND PICKING BELT.[1]

Analyses.

COLLIERY AND SEAM.	MOISTURE.		PROXIMATE ANALYSIS OF DRY COAL.			ULTIMATE ANALYSIS OF DRY COAL.					
	Mine.	Air-dried.	Vol.	F.C.	Ash.	C.	H.	S.	N.	O.	B.T.U. Dry coal.
	%	%	%	%	%	%	%	%	%	%	
Vale colliery, 6 feet	2·1	2·1	32·1	50·6	17·3	68·0	4·2	1·0	1·8	7·7	12,020
Allan shafts, Main	3·6	1·7	33·3	55·4	11·3	74·1	4·6	0·6	1·9	7·5	13,230
Albion, Third	2·0	.....	29·8	55·5	14·7	71·4	4·5	1·4	1·7	6·3	12,580 (run of mine)
Albion, Main	3·6	1·9	31·4	58·1	10·5	74·2	4·5	0·9	2·1	7·8	13,180 (run of mine)
Acadia, Main	1·8	1·6	26·0	64·8	9·2	77·6	4·7	0·9	1·6	6·0	13,860
Drummond, Main	1·4	1·1	24·7	60·8	14·5	72·6	4·3	2·5	2·1	4·0	12,960

[1] From "An Investigation of the Coals of Canada," Mines Branch, Dept. of Mines, No. 83.

Boiler Tests.

	Cal. value per lb. as fired. B.T.U.	Moisture in coal as fired. %	Ash and clinker from dry coal. %	Equivalent evaporation as fired. per lb.
Vale colliery, 6 foot seam	11,680	2·8	14·3	6·04
" " 6 foot washed	12,260	3·9	10·3	6·24
Allan shaft, colliery, Main	12,990	1·8	9·9	7·24
Albion colliery, 3rd seam	12,330	2·0	10·8	7·38
" " "	12,210	2·0	12·7	7·38
" " Cage pit	12,880	2·3	11·6	7·49
Acadia colliery, Main	13,640	1·6	8·2	8·55
" " "	13,660	1·5	8·37	8·25
Drummond colliery, Main	12,820	1·1	12·4	7·69
" " "	12,810	1·2	12·6	7·53
" " washed	13,320	1·7	9·03	8·07

Coking Tests.

Source of Coal.	Age of sample in months.	Type of oven.	Time of coking in hours.	Remarks.	Class of coke.
Vale colliery.....	16½	Otto-Hoffman at Sydney.....	48	Friable agglomerate, no good.	+C
Allan shaft, colliery, Foord seam..	16½	" " "	48	Good hard strong coke.....	A
" " " " " ..	½	" " "	48	Excellent coke.	+A
Albion colliery, Third seam.....	1	" " "	48	Soft friable agglomerate, not really bonded.	C
" " Cage Pit seam...	21	" " "	48	Dirty agglomerate, no true coke.	C
" " " " " ...	½	" " "	48	Good, hard, dense coke, regular fracture.	—A
Acadia colliery, Main seam.....	21	" " "	48	Good hard, strong coke.	—A
" " " "	½	" " "	48	Dense hard coke, first class quality.	A
" " " "	½	Beehive at Bridgeport.....	72	Good strong coke.	.....
Drummond colliery, Main seam....	21	Otto-Hoffman at Sydney.....	48	Dense, hard coke, not very regular fracture.	—A
" " " "	½	" " "	48	Similar to former, but harder and stronger.	A

A = Good commercial coke—subdivided +A, A, —A.
B = Poor commercial coke—subdivided +B, B, —B.
C = An agglomerate not commercial coke—subdivided +C, C, —C.

Gas Producer Tests.

Description.	Cage pit seam, Albion colliery, Acadia Coal Co., Stellarton.	Main seam, Acadia colliery, A. C. Co., Westville.	Main seam, Drummond colliery, I. C. Co., Westville.
Volatile matter	30·9%	27·5%	24·0%
Ash	10·9%	9·0%	12·0%
Moisture	1·9%	1·9%	1·3%
Cal. value of coal as charged. B.T.U.	12,920	13,600	12,780
" " " gas (lower) per cub. ft. B.T.U.	93·6	91·9	97·7
Producer efficiency	0·533	0·393	0·578
Coal per B.H.P. per hour	1·88 lbs.	2·28 lbs.	1·76 lbs.
Caking of coal	No trouble.	No trouble.	No trouble.
Average interval between poking	2½ hours.	2 hours.	2¼ hours.
Clinker	No trouble.	No trouble.	No trouble.
Tar	7 lbs.	55 lbs.	45 lbs.
Uniformity in gas quality	Fairly uniform.	Moderate.	Fairly uniform.
Amount of steam used	Considerable.	Small.	Considerable.
Combustible in refuse	Low in combustible.	High in combustible.	Moderate.
Remarks	Easily worked, good for producer work.	Easily worked, but made poor gas; should have done better.	Very little attention; good for producer work.

Summary of Coal Resources, Pictou Coal-field.

GROUP I.

Including Seams of 1 Foot or Over, to a Depth of 4,000 Feet.

District.	Coal-Seams.		Actual Reserve (Calculation based on actual thickness and extent).			Probable Reserves (Approximate estimate).		
	No.	Thickness.	Area square miles.	† Class of coal.	Metric tons.	Area square miles.	† Class of coal.	Metric tons.
Vale area	5	Aggregate 19½ feet.	4·7	B_2	42,800,000	.....	.....	.....
McLellan brook	4	Aggregate 15 feet.	3	C	45,000,000	.....	.....	.....
Stellarton	7	Aggregate 96 feet.	4·75	B_2	302,640,000	4·75	B_2	100,000,000
Stellarton lower seams	5	Aggregate 29 feet.	.....	.....	.....	4	B_2	100,000,000
Deep area between Vale and Stellarton	7	Aggregate 96 feet.	.....	.....	.....	4	B_2	250,000,000
			9·45	B_2	345,440,000	12·75	B_2	450,000,000
			3	C	45,000,000	.....	.....	.....
					Total.....	.....	.....	840,440,000

† For classification of coal, see Preface.

ANTIGONISH COUNTY.

North of Antigonish town on the Hallowell grant, the basal Carboniferous beds have been found to contain a few coal-seams. The shales associated with the coal-seams are, in places, of the nature of cannel. Twenty feet is given as the thickness of the shales, and they are supposed to underlie about 5 or 6 square miles of Carboniferous limestone at Big Marsh. The cannel may be suitable for utilization as an oil-shale. On the west shore of Pomquet harbour a small seam of coal 1 foot in thickness is reported.

RICHMOND COUNTY.

Several areas of Millstone Grit, with possibly some of the Coal Measures, are found in shallow basins in this county.

(1) An area reaching from Inhabitants basin east to Bras d'Or lake, covers about 80 square miles. At its western end many pits have been dug in the search for a mineable seam.

(2) A second area in the vicinity of the Strait of Canso is crossed by the Intercolonial railway from Point Tupper. The eastern edge is faulted against Lower Carboniferous limestone and just east of this, on Little river, coal in a highly inclined seam has been mined. This seam being in disturbed ground, mining has not been continued and the coal has not been traced to any mineable area. An old mine, recently reopened by the Richmond Coal Company, is reported to have shown two seams of 3 and 4 feet in thickness, standing vertically. The basin appears to be greatly disturbed, as the rocks are all pitching at high angles toward the centre.

(3) The third basin runs north from the western end of the first and the only occurrence of coal appears to be an 18-inch seam at Inhabitants basin.

(4) At the southern entrance to the Strait of Canso, the lower part of the Coal Measures is found in a small area on the east shore, at Bear head, separated by faults and intervening Lower Carboniferous beds from the Point Tupper area. At Seacoal bay in this area several seams are reported by Mr. J. Rutherford to be nearly vertical in position, having a dip to the southward of 75 degrees, the strike being N. 50° W. Three

seams of 4, 5½, and 11 feet in thickness, including shale bands, are reported, but mining has been carried on principally on one 4-foot seam. This area at Seacoal bay (3 square miles) and that near the Richmond mine on Little river, are the only areas so far proved to have mineable coal.

INVERNESS COUNTY.

INHABITANTS RIVER.

The southernmost exposure containing coal-seams is in a small basin at the headwaters of Inhabitants river. As the coal occurs near the centre of the basin and in the upper part of the series, the area underlain by coal-seams is not of large extent. The area is in true basin form, the rocks everywhere dipping toward the centre. The uppermost seam, which is the largest, is 1 foot 8 inches in thickness.

PORT HOOD.

The Port Hood area is made up of a submarine synclinal trough of Coal Measures with its eastern limb exposed on the shore, and a land area covered by the lower part of the Coal Measures. The land area contains a few thin seams, one being 20 inches thick, and may be considered as forming a small probable reserve, that is, a strip a mile wide and 3 miles long may be considered to have 1 foot of coal beneath it. The seam worked at the coast dips beneath the sea at an angle of 21 degrees, flattening to 12 degrees at 2,000 feet from the outcrop. The coal is between 6 and 7 feet in thickness.

MABOU.

The Mabou area is submarine, though the Coal Measures outcrop on Coal Mine and Finlay points. Two seams are known, 6 and 7 feet in thickness, both being mined by slopes. The measures dip seawards at an angle of 75 degrees or higher, but at 540 feet down the slope the dip changes to an easier angle of about 17 degrees.

BROAD COVE OR INVERNESS.

At the mouth of Broad Cove river a narrow belt of Coal Measures, resting on Pre-Cambrian at the south and on Lower

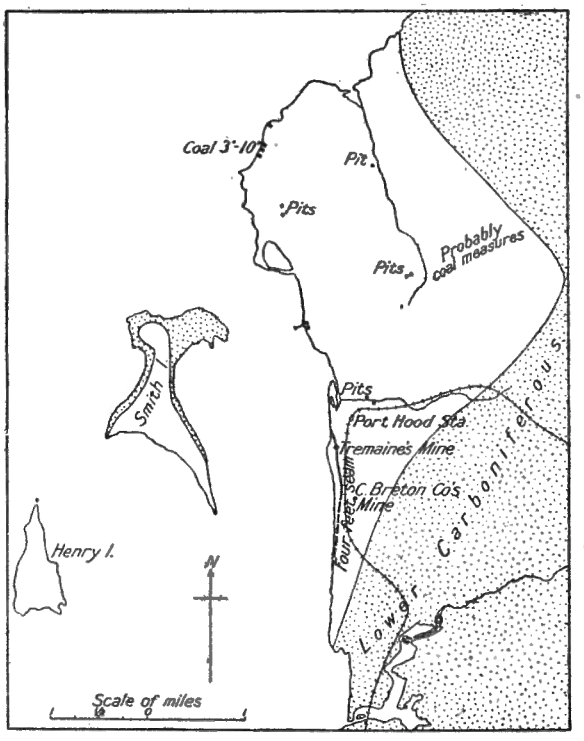

Figure 4. Port Hood coal-field.

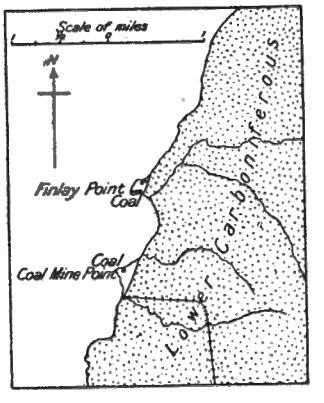

Figure 5. Mabou coal-field.

Carboniferous at the north, contains several seams, the exact areal distribution of which has not been determined. H. Y. Hind, in 1873, measured the following section of these beds:—

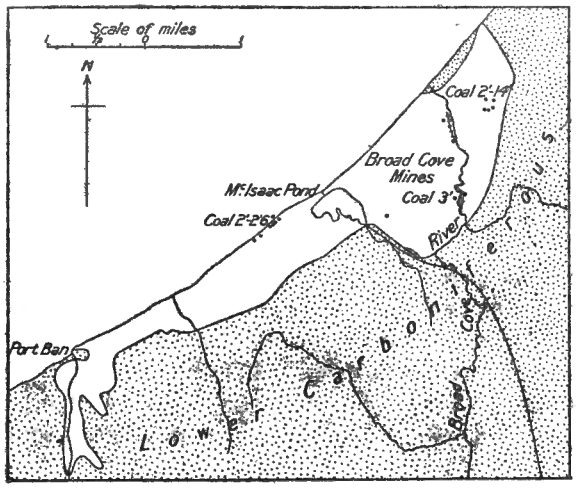

Figure 6. Broad Cove coal-field.

Upper Group.

Coal, the highest bed	3	feet.	
Strata	340	"	
Coal	5	"	
Strata	100	"	
Coal, main seam	7	"	
Strata	240	"	
Coal	3	"	6 inches

Lower Group.

Coal	2	feet	6 inches
Strata	60	"	

Coal—thickness unknown.

Mr. Chas. Robb gives the following section of the same beds:—

1. A 3-foot seam.
   Intervening strata with reported 5-foot seam....376 feet.
2. A 7-foot seam.
   Intervening strata.....437 "
3. A 4½-foot seam.
   Intervening strata.....303 "
4. A 3-foot seam.
   Intervening strata..... 32 "
5. A 3-foot 9-inch seam.

It may be expected, therefore, that an aggregate thickness of 21 feet of coal underlies the marine area, but as the lower beds only are found on the land area, the thickness there will average about one-third that amount. Mining has reached a point 2,000 feet from shore. The land area is less than 5 square miles and the sea area, at 1 mile wide, totals about 4 square miles.

CHIMNEY CORNER.

This field contains a somewhat larger land area than those already described, but it is not thought to contain as many valuable seams. The measures outcrop along the coast from Marsh point to Margaree harbour. Inland, the width opposite Chimney Corner is about 3 miles. The land area seems to be a shallow basin with the western edge turned downward toward the sea. In the northwestern portion, where the rocks are dipping seaward, the measures contain four coal-seams disposed, according to Professor Hind, as follows:—

1. Coal..... 1 foot 6 inches.
2. Strata, about.....300 feet
3. Coal..... 3 "
4. Strata..... 68 "
5. Coal, main seam..... 5 "
6. Strata.....200 "
7. Coal..... 3 "

The land area underlain by the above seams is estimated at three-quarters of a square mile. The presence of the lower part of the measures on Margaree island, 3 miles off shore opposite the southern part of the field, indicates that the sea area occupies a synclinal trough and is, therefore, definitely limited by the syncline, seaward; the seams should be mineable, however, to a distance of 1 mile from the shore. In the land area, a 3-foot seam, possibly the lowest one of the above section, has been found, so that part of this area may be included in the available reserve.

FRIAR POINT.

A narrow fringe along the shore of Friar point is made up of the lower part of the Coal Measures. Although no coal is found in the shore outcrops, it seems probable that the measures lying under the sea may be coal-bearing.

CHETICAMP ISLAND.

Coal Measures occur on Cheticamp island in the form of a narrow syncline, the axis of which is parallel to the coast. No coal has been found, but the occurrence of the syncline gives rise to the conjecture that it may be found near the middle of the island.

SUMMARY OF INVESTIGATIONS BY THE DEPARTMENT OF MINES OF COMMERCIAL SAMPLES OF COALS FROM INVERNESS CO. THAT HAVE PASSED OVER A $\frac{5}{8}$-INCH SCREEN AND PICKING BELT.[1]

Analyses.

MINE.	MOISTURE.		PROXIMATE ANALYSIS OF DRY COAL.			ULTIMATE ANALYSIS OF DRY COAL.					
	Mine.	Air-dried.	Vol.	F.C.	Ash.	C.	H.	S.	N.	O.	B.T.U. Dried coal.
	%	%	%	%	%	%	%	%	%	%	
Inverness mine	9·3	7·5	40·0	49·6	10·4	67·2	4·8	6·0	0·9	10·7	12,150
Port Hood mine	4·7	3·2	27·1	48·3	14·6	63·7	4·2	7·9	0·8	8·8	11,770

[1] From "An Investigation of the Coals of Canada," Mines Branch, Dept. of Mines, No. 83.

Boiler Tests.

Mine.	Cal. value per lb. as fired. B.T.U.	Moisture in coal as fired. %	Ash and clinker for coal. %	Equivalent evaporation per lb. as fired.
Inverness mine, raw	11,260	7·3	8·6	5·46
" " washed	11,620	9·2	6·0	5·67
Port Hood mine, raw	11,380	3·3	12·2	5·67
" " " washed	11,860	5·5	9·7	5·85

Coking Tests.

Source of coal.	Age of sample in months.	Type of oven.	Time of coking in hours.	Remarks.	Class of coke.
Inverness colliery	16½	Otto-Hoffman	48	A little caked but not coked	C
Port Hood colliery	16½	" "	48	Friable agglomerate, not commercial coke	+C

A = Good commercial coke—subdivided +A, A, —A.
B = Poor commercial coke—subdivided +B, B, —B.
C = An agglomerate not commercial coke—subdivided +C, C, —C.

Gas Producer Tests.

Description.	Port Hood colliery, Richmond Ry. and Coal Co.
Volatile matter	35·3%
Ash	12·7%
Moisture	2·8%
Cal. value of coal as charged. B.T.U.	11,440
" " " gas (lower) per cub. ft. B.T.U.	116·1
Producer efficiency	0·398
Coal per B.H.P. per hour	2·78 lbs.
Caking of coal	Very little.
Average interval between poking	2½ hours.
Clinker	No trouble
Tar	70 lbs.
Uniformity in gas quality	Fairly uniform.
Amount of steam used	Small.
Combustible in refuse	Rather high in combustible.
Remarks	Fairly suitable for producer work.

Summary of Coal Resources, Inverness County.

GROUP I.

Including Seams of 1 Foot or Over, to a Depth of 4,000 Feet.

District.	Coal-Seams.		Actual Reserve (Calculation based on actual thickness and extent).			Probable Reserves (Approximate estimate).		
	No.	Thickness.	Area square miles	Class of coal.†	Metric tons.	Area square miles.	Class of coal.†	Metric tons.
Inhabitants river	.....	.....	.....	.....	.....	1	B_2	1,000,000
Port Hood	1	1 foot	Land	.....	.....	3	B_2	3,000,000
Port Hood	1	6 feet	Marine	.....	.....	2	B_2	12,000,000
Mabou	2	6 and 7 feet	1	B_2	12,000,000	3	B_2	36,000,000*
Broad cove—								
Marine	6	Aggregate 21 feet	4	B_2	86,000,000	.....	.....	.....
Land	6	Aggregate 7 feet	4	B_2	28,800,000	.....	.....	.....
Chimney Corner—								
Land	4	Aggregate 12½ feet.	¾	B_2	21,000,000	.....	.....	.....
	1	Aggregate 3 feet	.....	B_2	.....	6	B_2	18,000,000
Sea	4	Aggregate 12½ feet.	.....	.....	.....	2	B_2	25,000,000*

* Possible reserve—Moderate.
† For classification of coal see Preface.

CAPE BRETON COUNTY.

Millstone Grit measures underlie a narrow basin between Loch Lomond and Mira lake. In this area exposures of coal are known to occur at three localities, viz., on Salmon River road, where two seams each 18 inches thick have been found, separated by a parting which varies from a few inches to 4 feet; near the head of Gaspereau river; and south of the Gaspereau River road, where 18 inches of coal occurs.

Millstone Grit also underlies the Coal Measures exposed at the northern boundary of the county. Near the top of the formation a few seams appear to be persistent and are, therefore, included in the estimate of reserve.[1]

SYDNEY COAL-FIELD.

(See Map 127A in pocket.)

The extreme northern part of Cape Breton county is occupied by the Coal Measures and underlying Millstone Grit, which, along the Atlantic coast, dip toward the sea at low angles. The beds are affected by a number of folds and minor flexures, but there appear to be no important structural breaks, and at Sydney harbour and Indian bay, mining operations beneath the sea have shown that the coal-seams are continuous beyond the points where, from a consideration of the structure, faults might be expected to occur. Shallow synclines occur at Bras d'Or, Sydney harbour, opposite Table head, and in Morien bay; and low anticlines in Indian bay and at Cape Percy.

A great area of coal-bearing rocks has been removed by erosion; but from the undisturbed condition of the land areas it may be expected that the undersea area is undisturbed and that a large portion of its coal, to a limited distance from shore, will ultimately be utilized.

The Cape Dauphin area in the west, which is separated from the others by the Great Bras d'Or channel, is small and ends against a fault running seaward in which the downthrow is on the east side.

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[1]See also Descriptive Note on the Sydney Coal-Field, by Hugh Fletcher, Geological Survey of Canada publication No. 685.

Sydney harbour cuts off the Boularderie and Sydney Mines district from the Victoria-Lingan area.

Indian bay and Cape Percy bound the Glace Bay district, and the synclinal basin at Port Morien, often called the Cow Bay, or Morien, basin, is separated from the Glace Bay district by the rocks of the Cape Percy anticline.

The coal-seams throughout the whole field are generally very uniform in thickness, although in a few instances they show partings and local interruptions, owing to which there is a little uncertainty as to the correlation of the seams of the various fields.

Notes on the Seams.

Point Aconi. This seam is the highest exposed in the field. It outcrops only on Point Aconi, where it has a thickness of 3 feet 2 inches. Measures beneath, about 242 feet.

Bonar, Cranberry Head or Seam A of Low Point. This seam is exposed across Bonar and Plant points in two layers, each 3 feet thick. On Cranberry head only the lower layer, 3 feet 8 inches thick, is found, and on Low point, one of the layers outcrops, varying from 2 to 4 feet in thickness. Measures beneath, practically barren, 218 feet on Boularderie island, 281 feet at Sydney Mines, and 306 feet on the east side of Low point.

Stubbart, Lloyd Cove, Paint or Carr. This seam is thick to the west but splits into two at Sydney harbour. Stubbart and Lloyd Cove seams vary from 7 feet 6 inches at the west, to 8 feet 1 inch in the middle, and 6 feet 4 inches at Sydney harbour. East of this the Paint seam has 7 feet of coal with a parting of 3 feet. The Carr seams show coal 2 feet, rock 22 feet 6 inches, coal 3 feet 6 inches. Measures beneath, barren of workable seams, 314 feet at the west, 231 feet at Little Bras d'Or, 258 feet on Low Point west shore, and 338 feet on Lingan shore.

Sydney Main, Victoria, David Head, Harbour, and Blockhouse. This seam, under the names given above, can be traced across the various areas. In the west it is a 4-foot seam, the

thickness increasing to 6 feet at Sydney Mines. On the east shore of Sydney harbour its width is 7 feet and in Victoria Mines it is called a 6-foot seam. At David head the thickness is 7 feet. In the Glace Bay area, at the shore near Bridgeport, it is 7 feet 9 inches, with a parting nearly 3 feet in thickness near the top, leaving 6 feet of clean coal at the bottom. At Glace Bay the section is 5 feet 2 inches. In the Morien basin, the Blockhouse seam averages about 8 feet.

A small seam underlies the Victoria in the Lingan tract. At the Sydney Harbour shore it is 40 feet below the Victoria seam and has about 1 foot of coal. At David head, at the east outcrop, it is 30 feet below with 2 feet 5 inches of coal. In the Glace Bay section it varies from 1 foot 9 inches at Bridgeport to 1 foot 5 inches at Glace Bay.

The barren measures to the next seam are 200 to 300 feet thick west of Sydney harbour. East of this, on Lingan tract, the thickness varies from 308 feet at Victoria Mines to 235 feet at David head. At Bridgeport the thickness is 238 feet and at Glace Bay 299 feet. In the Port Morien basin the thickness varies from 319 feet on the north side to 285 feet on the south.

Bryant, Willie Fraser, Fairy House, Bouthelier, and Seam D. This seam, known under the above names at various localities, is probably represented at each end of the field by a small seam 1 foot thick. From Sydney harbour to Indian bay it averages over 3 feet. In the Glace Bay area, as the Bouthelier seam, it attains a maximum of 4 feet at the north, but decreases to 2 feet 7 inches at the east. In the Morien basin it is not over 1 foot in thickness.

Below this the barren measures vary in thickness, being 78 feet at the west end, 117 feet at Sydney harbour, 92 feet at Bridgeport, and 74 feet at Glace Bay. In the Morien basin the thickness varies from 130 to 107 feet.

Millpond, Edwards, Indian Cove, Number Three, Northern Head, Back Pit, and Seam E. The above-named seams are here correlated, as they occur at or near the same horizon. In the area west of Sydney harbour the Millpond-Indian Cove seam varies in thickness from 3 feet 11 inches to 4 feet 8 inches, and across the harbour, as Number Three and Northern Head,

a minimum of 3 feet 6 inches and maximum of 5 feet are found. In the Glace Bay area from 4 feet to 4 feet 9 inches of coal is exposed in pits, etc. In the Morien basin the seam thins down to 3 feet 2 inches and 2 feet. A small seam of cannel coal, averaging 1 foot 3 inches, is found 69 feet below this in the section from Sydney harbour east to Northern head. Barren measures (containing, however, the above-mentioned cannel seam) average about 100 feet.

Seam F. H. McGilvary, Lingan Main, Phelan, Gowrie, and McAulay. The seams known under these various names appear to belong to one horizon. Starting at the west between 2 and 3 feet thick, this seam thickens, east of Sydney harbour, to 6 feet 3 inches, and attains a maximum of 8 feet 7 inches at Bridgeport. It is 8 feet 3 inches at Glace Bay, and in Morien basin it will average over 5 feet.

In the Lingan tract a dirty seam one foot in thickness is found in the underlying sandstones halfway to the next important seam. The measures are about 100 feet thick as far east as the Glace Bay area, where they thicken to 215 feet on the north side of Morien basin and decrease to 187 feet at the southern.

Blackrock, Collins, Stony, D. McGilvary, Seam G, Emery, Ross, and Spencer. This series of names is supposed to apply to one seam which lies at the base of the Coal Measures. In the field west of Sydney harbour it is a 3-foot seam with, in places, thicker parts such as the "Collins," a 5-foot seam. East of Sydney harbour it dwindles to 2 feet 2 inches and 2 feet 6 inches, reaching a minimum at Indian bay. The Emery or Ross seam in Glace Bay basin has a maximum of 5 feet 9 inches. In the Morien basin its equivalent, the Spencer seam, is 5 feet thick on the north side of the syncline and at South head is 3 feet 9 inches.

The sandstones beneath this seam may properly be placed in the Millstone Grit, and, with the exception of a few small seams in the Glace Bay district, form a heavy sandstone rib.

The Millstone Grit formation has several seams that are mineable in the eastern part of the field.

Seam H., Lorway, Gardiner, and Long Beach. This seam is found at Sydney harbour and runs east to Indian bay, averaging probably 1 foot in thickness. In the Glace Bay area either this thickens or a larger seam beneath starts near Indian bay and is continued as the Lorway or Gardiner, with an average of 4 feet 6 inches of coal. In the Morien basin the Long Beach seam at about this horizon has 1 foot 4 inches of coal on the north and 3 feet 9 inches on the south side of the syncline. Several seams of minor importance occur in the vicinity of Bridgeport basin. The Young seam on the north shore and the Clarke south of the railway appear to be in the same horizon.

Mullins. The small seam in the Millstone Grit at Little Bras d'Or, as well as the Ingraham seam near Stubbart point, may be the western continuation of the Mullins seam. On the east shore of Sydney harbour, the thickness is 6 feet, with a parting 2 feet from the top. Inland to the east the parting thickens and at the Carrol pits is 3 feet; near Bridgeport basin it is 7 feet. In the low country at the head of this inlet the upper part of the divided seam appears to form the Martin seam, and the lower is probably thinning out to the south.

Coal Brook. This seam outcrops from Cochran lake eastward to the shore of Mira bay, with an average thickness of about 1 foot 6 inches.

Tracy. The outcrop of this seam is to the south of the Morien syncline, and its presence under the anticline between this and Glace bay is said to have been proved by boring at the top of the anticline where crossed by the old railway to Louisburg, or 2 miles west of the present road. The seam has been tested at a number of places along its outcrop from Macdonald lake to Mira bay. The thickness is generally over 5 feet, but there are several partings, leaving a clean portion of 3 feet that is generally mined.

Sea Areas.

Mining operations are being extended under the sea at several points in the Sydney field. Under the entrance to Sydney harbour, in the mines at Cranberry head, galleries have been

driven on the Main seam to the boundaries of the leaseholds. The Bridgeport mines have galleries on the Phelan seam extending over a mile from the shore of Indian bay, and mines at Table head have galleries $1\frac{1}{4}$ miles beneath the sea on the Hub seam. On this seam, at a distance of a mile from the shore, some small rolls or undulations parallel to the coast were passed through. These are the only disturbances in the regularity of the measures and it, therefore, seems possible to extend the workings everywhere to the limit of haulage and ventilation. In the estimate of the amount of coal, the limit for probable reserves is fixed at 3 miles from the shore and that for possible reserves at 5 miles.

SUMMARY OF INVESTIGATIONS BY THE DEPARTMENT OF MINES OF SAMPLES OF COALS FROM CAPE BRETON CO. THAT HAVE PASSED OVER A $\frac{5}{8}$-INCH SCREEN AND PICKING BELT.[1]

Analyses.

SOURCE OF COAL SEAM AND MINE.	MOISTURE.		PROXIMATE ANALYSIS OF DRY COAL.			ULTIMATE ANALYSIS OF DRY COAL.					
	Mine.	Air-dried.	Vol.	F.C.	Ash.	C.	H.	S.	N.	O.	B.T.U. Dry coal.
	%	%	%	%	%	%	%	%	%	%	
Hub, Dominion No. 7.....	3·5	2·6	36·5	57·6	5·9	76·7	5·0	2·4	1·6	8·4	13,860
Harbour, Dominion No. 9.....	2·4	1·6	38·6	55·5	5·9	77·0	5·2	3·7	1·5	6·7	14,000
Main, Sydney Mines, No. 3.....	5·4	4·0	39·0	54·3	6·7	74·9	5·1	2·5	1·4	9·4	13,680
" " " No. 1.....	3·5	2·7	37·4	55·4	7·2	75·4	5·1	2·9	1·3	8·1	13,770
Gowrie, North Atlantic coll	2·8	.....	34·7	53·0	12·3	70·5	4·8	6·4	1·0	5·0	12,620
Phelan, Dominion No. 5.....	3·4	1·9	35·0	59·5	5·5	78·6	5·3	1·8	1·4	7·4	14,040
Lingan, " No. 12.....	4·9	3·6	37·3	57·9	4·8	77·6	5·2	1·8	1·6	9·0	13,790
Emery, " No. 10.....	4·0	2·0	35·1	53·8	11·1	73·3	4·9	2·5	1·2	7·0	13,120

[1] From "An Investigation of the Coals of Canada," Mines Branch, Dept. of Mines, No. 83.

Boiler Tests.

Source of Coal.	Cal. value per lb. as fired. B.T.U.	Moisture in coal as fired. %	Ash and clinker for dry coal. %	Equivalent evaporation per lb. as fired.
Hub, Dominion No. 7	13,490	2·7	5·64	7·08
" " " " washed	13,670	4·5	3·77	7·33
Harbour, Dominion No. 9	13,750	1·8	6·58	7·21
Main, Sydney Mines, No. 1	13,450	2·3	5·9	6·74
" " " " " washed	14,010	3·3	5·0	7·01
" " " " 2	13,110	4·2	7·1	6·77
Phelan, Dominion No. 1	13,620	2·8	5·2	7·40
Emery, Dominion No. 10	12,750	2·8	9·8	6·90
" " " " washed	13,260	4·5	5·95	7·17

Coking Tests.

Source of Coal.	Age of sample in months.	Type of oven.	Time of coking in hours.	Remarks.	Class of coke.
Gowrie seam— North Atlantic Collieries, Lt. Port Morien.	½	Otto-Hoffman at Sydney	40	Open cellular coke; breaks up easily but without producing much breeze.	A
Hub seam— Dominion No. 7, Glace Bay	5½	" " "	48	Very pretty coke but not very strong; breaks into curved rods.	+A
" " " " "	½	" " "	48	Brighter and stronger than older sample.	+A
Harbour seam— Dominion No. 9	5½	" " "	48	Breaks up rather easily owing to cross fractures. Good hard coke.	A
" " "	½	" " "	48	Rather brighter and better	A

Coking Tests—(Continued).

Source of Coal.	Age of sample in months.	Type of oven.	Time of coking in hours.	Remarks.	Class of coke.
Phelan seam—					
Dominion No. 5.....	5½	Otto-Hoffman at Sydney.....	48	Ordinary good coke in appearance.	A
" " "	½	" " "	48	Good sound coke.....	A
" " "	½	Beehive at Bridgeport.....	72	Makes good deal of breeze, not as good coke as above.	.....
" " 1.....	5½	Otto-Hoffman.....	40	Good strong coke, breaks into curved rods.	+A
" " "	5½	Bernard at Sydney Mines....	48	Good strong coke, not as good as above.	A
" " "	½	" " " "	48	Good coke, not as good as above.	—A
Emery seam—					
Dominion No. 10.....	5½	Otto-Hoffman.....	48	Not very strong coke.....	+B
" " "	5½	"	48	Makes better coke than older sample.	—A
Lingan seam—					
Dominion No. 12.....	5½	"	40	Bright, hard coke, but breaks easily.	A
" " "	5½	Bernard.....	48	Very nearly as good as above..	—A
" " "	½	"	48	Slightly stronger.....	—A
Sydney Main, No. 1 colliery..	17½	"	48	Fair coke, regular fracture.....	—A
" " " " " ..	½	"	48	Friable on account of slate.....	—A
" " " 3 " ..	17½	"	48	Fair coke.....	B
" " " " " ..	17½	Otto-Hoffman.....	41	Fair coke, breaks rather easily.	+B
" " " " " ..	½	Bernard.....	48	Very friable.....	B

A = Good commercial coke—subdivided +A, A, —A.
B = Poor commercial coke—subdivided +B, B, —B.
C = An agglomerate, not commercial coke—subdivided +C, C, —C.

Gas Producer Tests.

Description.	Hub seam. D. C. Co.	Harbour seam. D. C. Co.	Phalen seam. D. C. Co.	Emery seam. D. C. Co.	No. 2 colliery. N. S. S. & C. Co.
Volatile matter %	35·0	35·1	32·5	34·2	35·4
Ash %	5·0	10·9	6·5	11·1	7·8
Moisture %	2·4	1·4	2·2	2·1	3·6
Cal. value of coal as charged B.T.U.	13,520	13,800	13,700	12,840	13,180
Cal. value of gas (lower) per cub. ft. B.T.U.	106·5	107·3	110·0	100·3	98·0
Producer efficiency	0·420	0·480	0·385	0·432	0·491
Caking of coal	Tends to cake.	Some trouble.	Tends to cake.	Slight.	No trouble.
Average interval between poking	1 hour.	55 mins.	1 hour.	2 hours.	1¾ hours.
Clinker	No trouble.	Trouble from arching	Small amount.	No trouble.	No trouble.
Tar	94 lbs.	148 lbs.	137 lbs.	97 lbs.	83 lbs.
Uniformity in gas quality.	Rather variable.	Variable.	Rather variable.	Rather variable.	Fairly uniform.
Amount of steam used	Moderate.	Moderate.	Small.	Moderate.	Moderate.
Combustible in refuse	Low in combustible.	High in combustible.	Very high in combustible.	Moderate.	Moderate.
Remarks	Considerable attention needed, but should have done better.	Great deal of attention needed, but should have done better.	Good deal of attention, not very good for producer work.	Not much attention fairly suited for producer work.	Not hard to coke, fairly well suited for producer work.

Summary of Coal Resources, Cape Breton County.

GROUP I.

Including Seams of 1 Foot or Over, to a Depth of 4,000 Feet.

Sydney Field, Nova Scotia. Land areas. Sea area to three mile limit.

District.	Coal-Seams.		Actual Reserve (Calculation based on actual thickness and extent).			Probable Reserves. (Approximate estimate).		
	No.	Thickness.	Area in square miles.	Class of coal.†	Metric tons.	Area in square miles.	Class of coal.†	Metric tons.
New Campbellton	4	Aggregate 14 feet.	1·73	B_2	13,073,000			
Boularderie and Sydney Mines.	10	Aggregate 36 feet.	22·42	B_2	295,126,000	52·0	B_2	1,291,748,000
Victoria and Lingan	12	Aggregate 46 feet.	11·65	B_2	125,292,000			
Victoria and Lingan	1	Aggregate 1 foot 3 inches	3·5	C	4,406,000	45·0	B_2	1,157,432,000
Glace Bay	10	Aggregate 43 feet.	30·0	B_2	411,227,000	47·5	B_2	1,359,857,000
Glace Bay	2	Aggregate 2 feet 9 inches	0·36	C	1,009,000			
Port Morien	9	Aggregate 29 feet 10 inches	23·0	B_2	177,778,000	24·0	B_2	254,420,000
Totals	....	.....	92·66	B_2 C	1,022,496,000 5,415,000	168·5	.....	4,064,357,000

† For classification of coal see Preface.

GROUP II.

INCLUDING SEAMS OF 2 FEET AND OVER, AT DEPTHS BETWEEN 4,000 AND 6,000 FEET.

DISTRICT.	COAL-SEAMS.		PROBABLE RESERVES (Approximate estimate).		
	No.	Thickness.	Area in square miles.	Class of coal.	Metric tons.
West of Sydney Harbour*...	10	Total 31 ft.....	23	B_2	734,000,000
East of Sydney Harbour*....	11	Total 40 ft.....	40	B_2	1,648,000,000
Port Morien*.....	9	Total 25 ft.....	10	B_2	257,000,000
Totals.....			73	.....	2,639,000,000

* Marine fields 3 to 5 miles from shore.

CHAPTER III.

NEW BRUNSWICK.

(See Map 126A in pocket.)

INTRODUCTORY.

The Carboniferous Coal Measures, developed in great thickness in Nova Scotia, seem to be almost altogether absent in New Brunswick. The underlying coarse-grained series, here generally correlated with the Millstone Grit, is found to contain a few small seams of coal. The formation covers a large part of the province, and as the rocks are nearly horizontal, small beds of coal that are not deeply covered may be cheaply mined. Exploration shows that one horizon at least contains coal, disposed in two thin seams, separated by a varying thickness of shale and sandstone. Where the parting is narrow, the two seams may be worked together. The upper of the two seams has been found with a maximum thickness of 30 inches, and over several mineable areas averages about 22 inches. The lower is seldom over 10 inches in thickness.

AREAS MINED.

Queens County.

Near the head of Grand lake, three small areas are being mined, in the vicinity of Minto, Coal creek, and Salmon river. The seam mined has a very light cover at several places and the coal is often obtained by stripping. At most of the mines the parting between the two seams is too great to allow of both being mined, so that only the upper coal, 18 to 22 inches in thickness, is extracted. With the small overburden the expenses of mining are small and all the coal of the seam is extracted.

Kent County.

Beersville, connected with the Intercolonial railway at Coal Branch station, is the centre of a small mining industry. They are here working an 18-inch seam, supposed to be the same as the one mined at Grand lake. In exposures a short distance away, the seam is only 10 inches thick, so that the mineable area is probably less than that at Grand lake.

Kings County.

A narrow basin of Millstone Grit to the south of the main area, and connected with it near Moncton, has been prospected near Dunsinane, with the result that on Stones brook an 18-inch seam has been discovered and some small shipments of coal have been made.

OUTLYING DISCOVERIES OF COAL.

Most of the exposures noted in the following notes are thin seams that are not of present importance except in determining the limits within which mineable areas may be found by boring.

Queens County.

An exposure of coal near Clones Settlement, having 2 feet 9 inches of coal, was proved by boring to be a local thickening of the seam and no mineable area was located.

Sunbury County.

A 5-inch seam is recorded as being exposed on the northwest branch of Oromocto river near the western boundary of the county.

York County.

Small seams, probably not of workable thickness, are found on the Nashwaaksis river north of Fredericton.

Gloucester County.

Thin seams of coal are reported to occur at several places along the shore of Chaleur bay; but they are not of present value. At Clifton a seam from 8 to 16 inches thick has been found and near Caraquette one from 6 to 10 inches thick.

Northumberland County.

On Dungarvon river a 12-inch seam is exposed and near Doaktown, on the southwest Miramichi river, a thin seam is reported.

Westmorland County.

In a boring 1 mile north of Moncton, 16 inches of coal is reported.

St. John County.

Anthracite coal mixed with shale was found at Lepreau in a thick seam, but as the amount of coal is small no mining has been done.

CHARACTER OF THE COAL.

The coal is bituminous and contains in places a large percentage of sulphur and ash, which can be reduced by hand-picking, so that the cleaned output is equal to the Nova Scotia steam coals.

AMOUNT OF COAL.

An estimate made by Professor Bailey in the Report of Progress, Geological Survey, 1872-73, page 224, gives:—

Area—	Newcastle coal-field about.....	32 square miles.
	Salmon River coal-field about.....	32 " "
	Coal Creek coal-field about.....	48 " "
		112 square miles

"Adopting 20 inches as the average thickness of the coal-seam and 79.4 pounds as the weight of a cubic foot of coal (sp. g.=1.27) and deducting one-fourth for the area occupied by Salmon river and Grand lake, the total amount of coal within the area in question would be (at the rate of 2,000 pounds to the ton) not less than 154,948,147 tons." (138,346,560 metric).

To this may now be added the Beersville area approximating 5 square miles and about 4 square miles at Dunsinane.

SUMMARY OF AN INVESTIGATION BY THE DEPARTMENT OF MINES OF SAMPLES OF COAL FROM QUEENS COUNTY THAT HAVE PASSED OVER A ¾-INCH SCREEN.[1]

Analysis.

SOURCE OF COAL.	MOISTURE.		PROXIMATE ANALYSIS OF DRY COAL.			ULTIMATE ANALYSIS OF DRY COAL.					
	Mine.	Air-dried.	Vol.	F.C.	Ash.	C.	H.	S.	N.	O.	B.T.U. Dry coal.
King's mine.....	1·3	0·9	32·2	53·4	14·4	70·3	4·6	5·8	0·6	4·3	12,890

Boiler Tests.

SOURCE OF COAL.	Cal. value of coal per lb. as fired. B.T.U.	Moisture in coal as fired. %	Ash and clinker for dry coal. %	Equivalent evaporation per lb. as fired.
King's mine	12,800	0·7	11·3	6·03
" " washed.....	13,590	1·7	9·4	6·80

[1] From "An Investigation of the Coals of Canada," Mines Branch, Dept. of Mines, No. 83.

Coking Tests.

Source of Coal.	Age of sample in months.	Type of oven.	Time of coking in hours.	Remarks.	Class of coke.
King's mine.....	21½	Bernard.	48	Dense, strong coke.	—A

A = Good commercial coke—subdivided +A, A, —A.
B = Poor commercial coke—subdivided +B, B, —B.

Gas Producer Test.

Description.	King's mine, Minto, N. B.
Volatile matter %.....	32·7
Ash %.....	12·7
Moisture %.....	1·3
Cal. value of coal as charged. B.T.U.....	12,720
" " " gas (lower) per cub. ft. B.T.U.....	98·3
Producer efficiency.....	0·531
Coal per B.H.P. per hour. Lbs.....	1·69
Caking of coal.....	Very little trouble.
Average interval between poking.....	2 hours.
Clinker.....	No trouble.
Tar.....	119 lbs.
Uniformity in gas quality.....	Fairly uniform.
Amount of steam used.....	Moderate.
Combustible in refuse.....	Moderate.
Remarks.....	Gave poor gas and a good deal of tar, but very easy to work in producer.

Summary of Coal Resources of New Brunswick.

GROUP I.

Including Seams of 1 Foot or Over, to a Depth of 4,000 Feet.

District.	Coal-Seams.		Probable Reserves (Approximate estimate).		
	No.	Thickness.	Area in square miles.	Class of coal.[1]	Metric tons.
Grand Lake	1	22 inches	112	B_2	138,000,000
Beersville and Dunsinane	1	18 to 20 inches	9	B_2	13,000,000
Totals	.....	.....	121	.....	151,000,000

[1] For classification, see Preface.

CHAPTER IV.

ONTARIO AND MANITOBA.

ONTARIO.

The slope to James bay, from a short distance north of the height of land, is a gently sloping plain on which inequalities in the surface of the consolidated rocks are covered by deposits of boulder clay and, near the bay, by recent marine deposits. In the boulder clay, masses or lenses of woody material, the remains of former swamps, covered by an upper boulder clay, now form lignite deposits, though not at the present time of economic value. The light cover makes extraction easy and a cheap fuel may be derived from it in the future either by using it on the ground or by briquetting for transport. The area in which the material occurs is probably less than 10 square miles, and 25,000,000 tons is estimated as the extreme amount available.

MANITOBA.

The Cretaceous rocks exposed in the western part of Manitoba are all marine deposits except a thin basal series called the Dakota sandstone, which lies unconformably on Devonian limestone. Thin streaks of coal occur elsewhere in this sandstone formation, but have not been found within the boundaries of the province. On the higher part of the Cretaceous plateau of western Manitoba, undenuded remnants of Tertiary beds are found, the most prominent being a hill called Turtle mountain, on the International Boundary south of the town of Brandon. The hill rises from a nearly level plain of Cretaceous marine shales, and is found to be composed mainly of sands and light coloured shales which seem to have been deposited in fresh water. It is an outlier, once connected with the large area

of similar beds in Saskatchewan. The lower slopes have been explored at several points by boring, and small lignite seams have been discovered. The upper slopes have not been prospected and it seems possible that they may contain the eastern prolongation of seams found in similar beds in the western area. An estimate of the amount of coal can include, in the present state of our knowledge, only that underlying a small area on the slopes at the west end of the hill, where the lower seams are workable.

CHAPTER V.

SASKATCHEWAN.

(See map 128A in pocket.)

INTRODUCTORY.

Two coal-bearing formations are exposed in Saskatchewan. The higher is probably Tertiary in age, being comparable to the Fort Union group of North Dakota.

The Tertiary beds cover a wide extent of country in the southern part of the province where they form the lower portions of the Cypress hills, the greater part of Wood Mountain plateau, and the ridge or belt of elevated land forming the northern extension of the Missouri Coteau. Eastward they form a shallow synclinal basin in the Souris River valley, and occupy some of the higher country to the north. Outliers containing some of the lower beds may occur in portions of the country to the east, but these are not expected to prove of value as coal lands.

The lower coal-bearing horizon is the Belly River division of the Cretaceous. This formation resembles the Tertiary in colour and in the character of its fossils, but is separated from it by Cretaceous marine beds.

TERTIARY COAL, FORT UNION BEDS.

The Tertiary beds are exposed in the hilly country of southern Saskatchewan, and the underlying measures, outcropping in small gullies and river banks, contain lignite seams, many of which, especially in the Souris valley, are being mined. At the Estevan mines, an 8-foot seam produces most of the coal extracted. This seam is reported to increase in places to 15 feet in thickness to the northeast. North of the Estevan field, coal has been reported to occur at the following places:—

Near Cullen, 16 feet coal; 45 feet cover.

Near Arcola, 14 feet coal, 22 feet shale, 4 feet coal; 80 feet cover.

Near Wauchope, 8 feet coal; 250 feet cover.

In the hills west of Souris river coal is known to occur at the following places:—

Township*	Range†	Meridian.	Coal-seams.
1.....	22	West of 2nd	Seams 3 feet and 5 feet.
1.....	23	West of 2nd	Seams 1 foot 6 inches and 1 foot.
1.....	28	West of 2nd	Coal lease, thickness of seam not given.
1.....	29	West of 2nd	Seam 18 feet.
1.....	23	West of 3rd	Seam 2 feet 6 inches.
2.....	6	West of 3rd	Seam 4 feet.
3.....	19	West of 2nd	Seam 6 feet.
3.....	22	West of 2nd	Seam 9 feet.
4.....	15	West of 2nd	Seam exposed at water's edge.
4.....	16	West of 2nd	Two seams 7 feet each.
4.....	23	West of 2nd	Seam 5 feet near Bengough.
4.....	27	West of 2nd	Coal leases granted, thickness of seams not given.
4.....	2	West of 3rd	Seams 5 feet 4 inches and 6 feet.
4.....	8	West of 3rd	Coal lease granted, thickness not given.
5.....	25	West of 2nd	Seam 5 feet.
5.....	28	West of 2nd	Seam 5 feet.
5.....	1	West of 3rd	Seam 1 foot.
6.....	18	West of 3rd	Seam 2 feet.
6.....	22	West of 3rd	Seams 1 foot 3 inches.
7.....	27	West of 2nd	Seam 7 to 9 feet.
7.....	29	West of 2nd	Coal lease granted, size of seam not specified.
7.....	21	West of 3rd	Coal lease granted, size of seam not specified.
7.....	24	West of 3rd	Coal lease granted, size of seam not specified.
7.....	29	West of 3rd	Coal lease granted, size of seam not specified.
9 and 10...	28	West of 2nd	7 to 9 feet of coal in banks of valley.
12.....	24	West of 2nd	Two seams 2 feet and 3 feet 4 inches.

* Townships are numbered from the boundary line northward.
† Ranges are numbered west from specified meridians.

It will be seen from the above table that coal-seams of workable thickness are found over a very large area. Including all the ground over which the formation extends, the area is 11,840 square miles. In the estimate of the reserves half the above area is considered to be underlain probably by 4 feet of coal.

In the western part of the field the coal is generally brown in colour; in the central portion it is very nearly black and has the appearance of a sub-bituminous coal, but does not stand weathering.

Proximate Analyses of Outcrop Samples.

Locality.	Moisture. Air-dried coal.	Vol.	F.C.	Ash.
Halbrite.....	22·14%	33·66%	38·84%	5·36%
Webster.....	24·10	34·24	55·71	10·05

CRETACEOUS COALS, BELLY RIVER FORMATION.

This formation is exposed in the Saskatchewan valley, in the western part of the province. In Alberta the top of the formation is generally marked by a coal-seam. In Saskatchewan a few isolated exposures of coal occur in the upper part of the formation, varying from a 4-foot seam at the Saskatchewan river to isolated exposures in the northern part, where a maximum of 8 feet is reported. The eastern extension of the formation probably thins out beneath the marine beds which cover it in that direction. Southward it is overlain by the shales of the Upper Cretaceous; this has been proved in a borehole at Maple Creek, where at a depth of 196 feet the 4-foot seam was located. A second seam, 7 feet thick, was found 100 feet below the first, at Maple Creek, so that although the upper seam may not be exposed over much of the area outlined, the second may be looked for in the southern part.

Seams found in borings or natural exposures have the following thicknesses:—

8 feet at Brock.
2 feet at Kerrobert.
8 feet at Salvador.
4 feet at Unity.

The seams north of the Saskatchewan river do not appear to be persistent, so that trustworthy estimates of the amount of coal can be made for small areas only. The seams south of the Saskatchewan are more uniform, and a larger area in that district is, therefore, believed to be coal-bearing, though much of it is covered by other formations.

Proximate Analyses of Outcrop Samples.

Locality.	Moisture. Air-dried coal.	Vol.	F.C.	Ash.
Kerrobert	21·32%	34·00%	39·93%	4·75%
Unity	16·29	32·19	38·64	12·88
Brock	25·70	26·95	28·42	18·93

CRETACEOUS COALS, DAKOTA FORMATION.

A few occurrences of coal in the Dakota sandstone have been reported. This formation is exposed along the base of the Cretaceous plateau through Manitoba and into Saskatchewan, south of the Churchill river. At one place east of Lac LaRonge, a lignite seam, 2 feet 6 inches thick, in the lower part of the Cretaceous escarpment, was traced for 3¼ miles. A proximate analysis of an outcrop sample of this seam gave: moisture, 11·23 per cent; volatile, 30·97 per cent; fixed carbon, 34·80 per cent; ash, 33·00 per cent.

SUMMARY OF INVESTIGATIONS BY THE DEPARTMENT OF MINES OF SAMPLES OF COAL FROM SASKATCHEWAN.

Analyses.

LOCALITY.	MOISTURE.		PROXIMATE ANALYSIS OF DRY COAL.			ULTIMATE ANALYSIS OF DRY COAL.					
	Mine.	Air-dried.	Vol.	F.C.	Ash.	C.	H.	S.	N.	O.	B.T.U. Dry coal.
	%	%	%	%	%	%	%	%	%	%	
Taylorton.....	28·6	18·0	42·9	49·0	8·1	59·8	4·8	0·6	1·0	25·7	10,690
Estevan.....	30·9	18·2	40·0	43·2	16·8	57·7	4·3	0·5	1·0	19·7	9,650

Boiler Tests.

SOURCE OF COAL.	Cal. value of coal per lb. as fired. B.T.U.	Moisture in coal as fired. %	Ash and clinker for dry coal. %	Equivalent evaporation per lb. as fired.
Western Dominion colliery Taylorton.....	7,520	29·7	8·24	3·91

Gas Producer Tests.

Description.	Lignite from Western Dominion Collieries Ltd., Taylorton, Sask.	
Volatile matter %	32·8	43·3
Ash	7·2	11·1
Moisture %	23·3	13·4
Cal. value of coal as charged. B.T.U.	8,300	9,370
" " " gas (lower) per cub. ft. B.T.U.	112·7	117·4
Producer efficiency	0·578	0·488
Coal per B.H.P. per hr. Lbs	2·28	2·48
Caking of coal	None.	None.
Average interval between poking	5 hours.	6 hours.
Clinker	Very slight.	None.
Tar	None.	Gas washer not used, no tar.
Uniformity in gas quality	Very uniform.	Very uniform.
Amount of steam used	Very little.	None.
Combustible in refuse	(Not analysed.)	Moderate.
Remarks	Very suitable fuel for producer, easy to work.	Very suitable for producer, easy to work, no trouble.

Summary of Coal Resources of Saskatchewan.

GROUP I.

Including Seams of 1 Foot or Over, to a Depth of 4,000 Feet.

District.	Coal-Seams.		Actual Reserve (Calculation based on actual thickness and extent).			Probable Reserves (Approximate estimate).		
	No.	Thickness.	Area in square miles.	Class of coal†	Metric tons.	Area in square miles.	Class of coal†	Metric tons.
Belly River coal.....	1	Maximum 8 feet.....	18	D_2	108,000,000	1,500	D_2	11,000,000,000
	2	4 feet and 7 feet.....	.....	.....	.....	5,700	D_2	22,800,000,000
Tertiary coal.....	.....	Maximum 18 feet....	288	D_2	2,304,000,000	5,900	D_2	23,600,000,000
Totals.....	.....	.....	306	.....	2,412,000,000	13,100	.....	57,400,000,000

† For classification of coals see Preface.

CHAPTER VI.

ALBERTA.

(See Map 129A in pocket.)

INTRODUCTORY.

Coal is found in three distinct horizons in the Cretaceous, separated by shales of marine origin. The lowest, named by Dawson the Kootenay formation, is practically the base of the Cretaceous, and is considered of that age from its fossil flora; it lies just above the Fernie shale now known to be of Jurassic age.

Above this the Dakota formation, or a series of sandstones of about that horizon, contains plant remains but does not appear to be coal-bearing in an economic sense, and not until the top of the Belly River formation is reached do beds appear indicating land conditions of sufficiently long duration for the formation of coal. The coal horizon in the Belly River formation contains only few coal-seams, but its areal distribution makes it important.

The third coal horizon is at the top of the Cretaceous and includes part of the Paskapoo formation which is about the age of the Fort Union formation, a fresh-water deposit. The brackish and fresh-water deposits which are coal-bearing, thus seem to have been formed at the close of the Cretaceous and are found in beds called by Tyrrell the "Edmonton" formation. The three coal horizons are then as below:—

Edmonton and part of Paskapoo formation.

Belly River formation.

Kootenay formation.

The coal-seams in the lower part of the Paskapoo formation are not continuous over large areas, but in some places the areas that are mineable are large enough to be important.

The Paskapoo is not here tabulated as a coal horizon distinct from the Edmonton coal-bearing beds beneath it. The coals of the Cypress hills also, although generally called Tertiary, are supposed to be in the horizon of the Edmonton.

The Paskapoo and upper Edmonton beds occupy an area of 24,779 square miles all of which is, with the exception of 2,304 miles, included in the estimate for the underlying seams. The Cypress Hills area contains only 216 square miles.

GROUP I.

INCLUDING SEAMS OF 1 FOOT OR OVER, TO A DEPTH OF 4,000 FEET.

DISTRICT.	COAL-SEAMS.		ACTUAL RESERVE (Calculation based on actual thickness and extent).			PROBABLE RESERVES (Approximate estimate).		
	No.	Thickness.	Area in square miles.	Class of coal. †	Metric tons.	Area in square miles.	Class of coal. †	Metric tons.
Tertiary beds	....	2 feet	.....	.....	.....	2,520	D_1	23,721,000,000
Edmonton and lower Paskapoo beds, top seams,	....	.....	15,645	D_1	272,600,000,000	6,830	D_1	149,100,000,000
Edmonton beds, Edmonton seams	....	.....	9,590	B_2,D_1	111,097,000,000	20,340	D_1,B_2	268,161,000,000
Belly River beds	....	.....	.....	.....	.....	25,974	B_2, D_1, D_2	189,450,000,000
Kootenay measures	....	.....	32	B_2	884,800,000		A_2	100,000,000
			33	A_2	669,000,000	711		
				B_1	1,142,000,000	.....	B_1, B_2	43,022,600,000
			5,300	.....	386,392,800,000	56,375	.....	673,554,600,000
Arranged in the following classes of coal	....	.....	.....	D_2	.....	.....	D_2	26,450,000,000
				D_1	382,500,000,000	.....	D_1	464,821,000,000
				B_2	1,197,000,000	.....	B_2	139,161,000,000
				B_2, B_1	2,026,800,000	.....	B_2, B_1	43,022,600,000
				A_2	669,000,000	.....	A_2	100,000,000
					386,392,800,000	.....	.....	673,554,600,000
Less coal mined to 1911	....	.....	.....	.....	20,000,000			
					386,372,800,000			
GROUP II, including seams of 2 feet or over between depths of 4,000 and 6,000 feet	....	.....	.....	.....	.....	203	B_1	12,700,000,000

† For classification of coal see Preface.

EDMONTON FORMATION COALS.

The Edmonton formation is a series of beds formed at sea-level, or slightly above it, during the period of emergence of the central part of the continent from the sea and before its greater elevation during Tertiary time. A few coal-seams are found above the limits of brackish water formation, but most of the thicker deposits are supposed to have been derived from vegetation growing at low altitudes. The rocks of this division cover a large part of southern Alberta. The beds form a synclinal basin reaching from latitude 49 degrees to about latitude 55° 30′. The axis of the syncline is west of the middle and follows the general line of disturbance represented by the Rocky mountains. The eastern limb dips very slightly to the west, but in the western limb, in the foothills, steeper dips appear as the beds outcrop from beneath the Tertiary sandstones which occupy the middle of the syncline. Toward the north the dips are less pronounced and the trough broadens so that the formation is exposed over a larger area, and the coal-seams increase in thickness.

A group of seams which in places unite into one thick bed is found at the top of the Edmonton. The aggregate thickness of this group, south of the Bow river, is only about 5 feet, but it thickens steadily in a northwest direction. The maximum thickness is found on the North Saskatchewan river west of Edmonton where it outcrops as a 25-foot seam. A northward extension of this seam outcrops where the Grand Trunk Pacific railway crosses the Pembina river, and there is split into at least two 10-foot seams.

About 500 to 600 feet below the thick seam a series of smaller seams persist throughout the exposed eastern outcrop of the Edmonton from near the boundary line to north of Edmonton. At Calgary, these form a single seam; it is 13 feet thick, covered by 1,800 feet of Tertiary sandstone and clay. These seams are mined at Edmonton, Tofield, and various points between the Grand Trunk Pacific and Canadian Pacific main lines. The seams outcropping at Edmonton, belonging to the lower part of the formation, underlie approximately 29,930

square miles beyond the boundaries of the areas underlain by the upper seams, giving a total area containing available coal of this formation, of 52,405 square miles.

The coal of this basin shows a gradual change in character from lignite, in the extreme northeastern part, to a coking coal in the foothill areas. The following analyses from outcrop samples show this change in the case of the coal of the upper horizon.

Locality.	Moisture.	Vol.	F.C.	Ash.
Head of Pembina river (west of axis)....	4·32%	33·43%	56·47%	5·14%
Williams creek, Red Deer river (west of axis)	4·97	36·87	54·05	4·11
Mitford, Bow river (west of axis).....	4·41	40·32	48·27	7·00
Crowfoot creek (east of axis).....	11·25	35·59	47·24	5·92
Saskatchewan river (east of axis).....	11·88	35·31	47·06	5·08

SUMMARY OF INVESTIGATION BY THE DEPARTMENT OF MINES, OF MINE SAMPLES OF EDMONTON COAL.[1]

Analyses.

SOURCE OF COAL.	MOISTURE.		PROXIMATE ANALYSIS OF DRY COAL.			ULTIMATE ANALYSIS OF DRY COAL.					
	Mine.	Air-dried.	Vol.	F.C.	Ash.	C.	H.	S.	N.	O.	B.T.U. Dry coal.
Strathcona mine.....	22·7	18·2	41·0	47·6	11·4	62·9	4·5	0·4	1·3	19·5	10,730
Parkdale mine.....	22·5	18·9	37·8	51·3	10·9	65·3	4·6	0·4	1·2	17·6	10,910
Standard mine.....	23·5	19·8	42·0	49·9	8·1	65·6	4·5	0·4	1·3	20·1	11,360

[1] From "An Investigation of the Coals of Canada," Mines Branch, Dept. of Mines, No. 83.

Boiler Tests.

SOURCE OF COAL.	Calorific value of coal as fired. B.T.U.	Moisture in coal as fired. %	Ash and clinker for dry coal. %	Equivalent evaporation per lb., as fired.
Parkdale mine.....	8,760	19·7	11·4	4·98

Gas Producer Tests.

Description.	Lignite from Parkdale Coal Co. Ltd., Edmonton, Alberta.	Lignite from Standard Coal Co. Ltd., Edmonton, Alberta.	Lignite from Strathcona Coal Co. Ltd., Strathcona, Alberta.
Volatile matter %	28·7	31·2	30·9
Ash %	11·2	7·5	11·9
Moisture %	17·3	15·3	16·1
Cal. value of coal as charged. B.T.U.	8,940	9,610	9,010
" " " gas (lower) per cub. ft. B.T.U.	119·5	118·6	119·0
Producer efficiency	0·514	0·566	0·657
Coal per B.H.P. per hour. Lbs.	2·61	2·13	1·83
Caking	None.	None.	None.
Average interval between poking	2½ hours.	5 hours.	12 hours.
Clinker	None.	Slight.	Slight.
Tar	None.	None.	None.
Uniformity in gas quality	Very uniform.	Fairly uniform.	Fairly uniform.
Amount of steam used	None.	None.	Very little.
Combustible in refuse	Moderate.	(Not analysed.)	Little combustible.
Remarks	Easily worked, very suitable for producer.	Easily worked, very suitable for producer.	Very easy to work in producer.

SUMMARY OF COAL RESOURCES, EDMONTON FORMATION, ALBERTA.

GROUP I.

INCLUDING SEAMS OF 1 FOOT OR OVER, TO A DEPTH OF 4,000 FEET.

DISTRICT.	COAL-SEAMS.		ACTUAL RESERVE (Calculation based on actual thickness and extent).			PROBABLE RESERVES (Approximate estimate).		
	No.	Thickness.	Area in square miles.	Class of coal†	Metric tons.	Area in square miles	Class of coal†	Metric tons.
TOP OF EDMONTON FORMATION.								
South and east of Calgary	1	Average 5 feet	3,600	D_1	20,000,000,000	.....	D_1	8,000,000,000
North to Red Deer	....	Average 10 feet	2,400	D_1	26,600,000,000	1,200	D_1	13,400,000,000
Red Deer to Wetaskiwin	....	Average 15 feet	3,000	D_1	50,000,000,000			
Wetaskiwin to Saskatchewan river	....	Average 20 feet	1,620	D_1	36,000,000,000	.....	D_1	1,300,000,000
Saskatchewan to Athabaska	....	Average 25 feet	5,020	D_1	140,000,000,000			
Western upturn	....	Average 10 to 25 feet	.....	.....	.....	5,630	.....	126,400,000,000
Totals	....	.....	15,640	D_1	272,600,000,000	6,830	D_1	149,100,000,000
EDMONTON SEAMS.								
Beneath above areas	....	8 to 10 feet	.....	.....	.....	.....	D_1	99,000,000,000
Smoky river	....	5 feet	.....	.....	.....	12,000	.....	*60,000,000,000
Athabaska	2	Aggregate 10 feet	.....	.....	.....	1,200	D_1	14,000,000,000
Edmonton district	3	Aggregate 15 feet	3,225	D_1	53,900,000,000	.....	D_1	50,000,000,000
Beaver lake to Bow river	....	Aggregate 8 feet	6,314	D_1	56,000,000,000	.....	D_1	22,000,000,000
South of Bow river	....	Aggregate 2 feet	.....	.....	.....	5,850	D_1	13,000,000,000
Outer foothills north	....	Aggregate 10 to 50 feet	51	B_3	1,197,000,000	308	B_3	2,816,000,000
Outer foothills south	....	.....	.....	.....	.....	976	B_3	7,345,000,000
Totals	....	.....	9,590	.....	111,097,000,000	20,334	.....	268,161,000,000

* Possible reserve—large.

† For classification of coal see Preface.

BELLY RIVER FORMATION COALS.

An area of about 16,000 square miles in eastern Alberta is underlain by this formation. A belt along the borders of the area is generally considered to be the best part of the field, on account of the occurrence in it, near the top of the formation, of a very persistent coal-seam which has been eroded from a large part of the exposed area. In the northern part of the area the seams appear to be thin. Near Medicine Hat, in the river banks, two seams, each about 5 feet thick, are exposed; westward a seam of better grade coal is mined at Taber, while the seam mined at Lethbridge supplies a still better coal. This change in the quality of the coal is the result of pressure possibly due to a former greater overburden, and partly to the forces which uplifted the mountains. The change in character of the coal as the mountains are approached is shown in the following proximate analyses.

Locality.	Moisture.	Vol.	Fixed carbon.	Ash.
Redcliff, near Medicine Hat.....	20·54%	33·26%	41·15%	5·05%
Ten miles west of Medicine Hat....	16·82	31·90	43·98	7·30
McPhee mine.....	11·35	29·98	51·63	7·04
Taber mine.....	7·21	39·18	46·36	7·22
Galt collieries, Lethbridge.....	4·73	34·61	50·43	9·89

In the foothills, where these measures are exposed in several bands, the coal is generally much harder than in the plains area and is often a good coking coal. The following analyses, compared with those above, show the alteration due to greatly increased pressure.

Locality.	Moisture.	Vol.	Fixed carbon.	Ash.
Stoney Reserve, Morley.....	1·26%	41·30%	48·60%	8·84%
South Branch Sheep creek.....	2·50	35·88	56·64	4·98

The extension of the beds beneath those of the Edmonton formation has been proved by several bore-holes. The depths at which the top of the formation has been struck at various places and the thicknesses of the seams at these points are:—

Tofield,	depth, 1,050 feet;	coal, 4 feet.
Edmonton,	depth, 1,400 feet;	coal, 6 feet.
Calgary,	depth, 2,562 feet;	coal, 5 feet.
Calgary,	depth, 2,656 feet;	coal, 7 feet.
Calgary,	depth, 2,875 feet;	coal, 4 feet.

East of Medicine Hat, in Saskatchewan, two seams are found where the formation is pierced by a well at Maple Creek. One seam, 195 feet from the surface shows 4 feet of coal; the other, 292 feet from the surface shows 7 feet of coal.

In the Peace River valley, the Dunvegan series, which is considered to be of about the same age as the Belly River beds, though possibly representing a separate land area, contains a few outcropping coal-seams. The beds occupy a shallow synclinal trough similar to that of the Edmonton formation. The channels of the Peace and Pine rivers cut through the Dunvegan series in the vicinity of St. John exposing the lower shales. In the eastern part, only thin seams have been found, but to the west seams 2 feet in thickness have been discovered.

Summary of Investigations by the Department of Mines of Commercial Samples of Coal from the Lethbridge District.[1]

Analyses.

Locality.	Moisture.		Dry Coal.			Dry Coal.					
	Mine.	Air dried.	Vol.	F.C.	Ash.	C.	H.	S.	N.	O.	B.T.U.
	%	%	%	%	%	%	%	%	%	%	
Mine at Taber.....	13·0	11·7	36·0	49·9	14·1	64·5	4·7	1·4	1·5	13·8	11,040
Mine at Lethbridge...	8·4	7·9	37·5	51·5	11·0	66·5	4·9	0·8	1·7	15·1	11,710

[1] From "An Investigation of the Coals of Canada," Mines Branch, Dept. of Mines, No. 83.

Boiler Tests.

Source of Coal.	Calorific value of coal per lb. as fired. B.T.U.	Moisture in coal as fired. %	Ash and clinker for dry coal. %	Equivalent evaporation per lb. as fired.
Taber mine, Canada West C.C.	7520	29·7	8·24	3·91
Lethbridge, Galt collieries.....	10470	8·3	10·4	5·92

Coking Tests.

Source of Coal.	Age of sample in months.	Type of oven.	Time of coking in hours.	Remarks.
Canada West Coll., Taber.....	5½	Otto-Hoffman	48	Coal almost unaltered

Gas Producer Tests.

Description.	Lignite coal from Canada West Coal Co. Ltd., Taber, Alberta.	Lignite coal from Galt colliery, Alberta, Ry. and Irrigation Co. Ltd., Lethbridge, Alberta.
Volatile matter %	26·6	35·2
Ash %	16·3	9·4
Moisture %	12·6	7·8
Cal. value of coal as charged. B.T.U.	9650	10800
Cal. value of gas (lower) per cub. ft. B.T.U.	120·0	122·4
Producer efficiency	0·534	0·522
Coal per B.H.P. per hr. lbs.	2·42	2·13
Caking	None	Very slight
Average interval between poking	2¼ hrs.	1¾ hrs.
Clinker	Slight	None
Tar	Very little from scrubber	None
Uniformity in gas quality	Very uniform	Fairly uniform
Amount of steam used	Small amount	Small amount
Combustible refuse	Rather rich in combustible	Little combustible
Remarks	Very little trouble, easy to work	Good for producer work, very little trouble

SUMMARY OF COAL RESOURCES, BELLY RIVER FORMATION, ALBERTA.

GROUP I.

INCLUDING SEAMS OF 1 FOOT OR OVER, TO A DEPTH OF 4,000 FEET.

DISTRICT.	COAL-SEAMS.		ACTUAL RESERVE (Calculation based on actual thickness and extent).			PROBABLE RESERVES (Approximate estimate).		
	No.	Thickness	Area in square miles	Class of coal	Metric tons	Area in square miles	Class of coal**	Metric tons
Peace River area	1	1 foot				4,900	D_1	5,000,000,000
Seams of middle part Belly River formation								
Raymond to Red Deer	2	3 to 5 feet				3,500	D_1	11,000,000,000
						3,840	D_2	20,000,000,000
Northern part		1 foot				3,675	D_2	4,000,000,000
Seams at top of Belly River formation continuing beneath Edmonton formation								
West side—								
Sounding creek	1	1 foot				1,925	D_2	2,000,000,000
West to Red Deer	1	2 to 3 feet	*4,500			4,800	D_1	28,000,000,000
							B_3	
Lethbridge, northwest to Calgary	1 to 7	5 to 29 feet	*7,610			1,750	B_3	96,000,000,000
Wetaskiwin and Edmonton		5 feet	*3,080			420	B_3	19,000,000,000
East side—								
Irvine south		3 feet	†216			984	D_1	4,000,000,000
Manville north		5 feet				180	D_2	450,000,000
						25,974		189,450,000,000

* Under Edmonton. † Under Tertiary.

** For classification see Preface.

KOOTENAY FORMATION COALS.

As this formation is at or near the base of the Cretaceous and not far above the Carboniferous and Devonian limestone, it is deeply covered in the undisturbed areas east of the mountains and is exposed only in the uplifted fault-blocks that form the Rocky mountains, and at the crests of anticlines in the foothills.

The formation attains its maximum thickness of over 3,000 feet in the Elk River valley. The thickness is reduced somewhat toward the north, and to a greater extent in an eastern direction, as at Moose mountain, and to the east of the main range of the Rockies, where the formation seems to be only about 200 feet thick. The amount of coal varies with the thickness of the formation.

As the general system of mountain building has resulted in the formation of a series of fault-blocks which dip generally to the west, these blocks often have remnants of the softer Mesozoic beds along their western slopes, so that where the coal-bearing beds are present they occur in long strips lying against the up-thrust edge of the succeeding block to the west. Many of the areas are monoclinal blocks, but a few synclinal troughs are found. The coal is generally bituminous and of high grade. Semi-anthracitic to anthracitic varieties also occur and, as a whole, the formation produces the most valuable coal in Canada.

The Alberta areas are found both in the outer ranges and in the foothills, from near the International Boundary, northward to beyond the Athabaska river. North of that latitude most of the coal-bearing areas occur in the foothills. In the following paragraphs the areas are described, beginning at the south.

NORTH KOOTENAY PASS.

At the head of the south fork of the Oldman river, a narrow band of Kootenay rocks, lying near the fault line of the outer range of the Rockies, has been prospected and at least one workable seam has been found. The area is not being mined.

COLEMAN.

This field, in the form of a narrow strip of coal-bearing beds, crosses the Canadian Pacific railway at Coleman. Coal occurs in about 500 feet of the measures, but the important seams lie within a thickness of about 300 feet. Three of the principal seams are 16 feet, 10 feet, and 8 feet thick, respectively. The seams all dip west.

BLAIRMORE-FRANK.

(*See Map 130A in pocket.*)

The Blairmore-Frank area lies in a large fault-block, broken by many vertical faults and folds, one of which, of greater throw than the rest, exposes the underlying limestones for a distance of upward of 12 miles. The seams of the Kootenay formation are exposed in several bands which together constitute a mineable area of wide extent. Where the area is crossed by the railway, mines are in operation at Passburg, Bellevue, Hillcrest, Frank, and Blairmore. The measures at Blairmore contain about 50 feet of coal in seams of 10, 17, 3½, 3½, 17, and 6 feet, respectively. At Bellevue the section gives the following seams, 9, 17, 4½, 15, 4, and 3½ feet, respectively.

LIVINGSTONE.

This basin lies west of the Livingstone range and may be reached through the valleys of the Oldman, Highwood, and Sheep rivers. It is wider than most of the other basins and is divided at the north end by the upthrust and anticline of Mount Rae, and by a less important anticlinal upraise at the south. In the north, on Sheep creek, the section gives thirteen seams with an aggregate content of 43 feet of coal. At the extreme south, the section at Cat mountain gives a possible 21 seams with 125 feet of coal. This area is not being mined, although considerable prospecting has been done.

MOOSE MOUNTAIN.

This area is in the foothills west and south of Calgary. An anticline, faulted in places on its eastern limb, exposes limestone beds in an oval-shaped area. Around this about 200 feet of the Kootenay beds are exposed. The coal-seams are 7, 8, and 20 feet in thickness, and it is thought that about 15 feet of coal can be mined. Coal is also found in the overlying Belly River beds of the vicinity.

KANANASKIS WATERSHED.

A portion of the Elk River coal-field crosses the Kananaskis watershed, which forms the boundary between the provinces of Alberta and British Columbia. The seams of the lower part of the measures are found there. One seam 13 feet thick has been uncovered, but little prospecting has been done.

CASCADE.

The block which contains the coal-bearing beds of this field extends from south of the Kananaskis river, north to near the Saskatchewan river. It is narrowed at the north end of

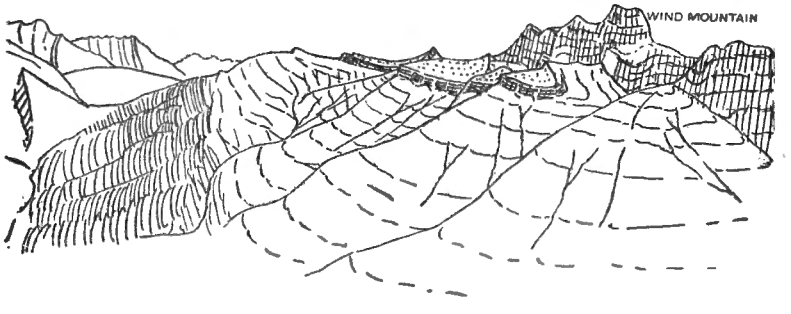

Figure 7. Sketch of Cretaceous coal-bearing measures east of Wind mountain.

Cascade mountain by an anticline, so that the coal-bearing beds are there interrupted, but for a distance of nearly 90 miles it forms an almost continuous coal-field. The southern end is narrowed south of Kananaskis to a small remnant folded

against the fault bordering the western edge of the coal formation. On the divide between the Bow and Kananaskis rivers, fifteen seams aggregating 85 feet have been discovered. Near the Kananaskis river, additional seams at the top of the section add 12 feet to this thickness. As denudation has removed a portion of the beds, the most of the coal occurs in the middle and lower seams which are the important ones in the field. The upturn of the upper portion in trough form is shown in the sketch (Figure 7).

Along the valley of the Bow river the measures present are the remnants of a formerly large series, which has been eroded in the process of valley-making, and the lower seams only are found. These are mined at Canmore and were formerly mined at Anthracite. In the valley of the Cascade rivers, the eastern flank of Cascade mountain is composed of westerly tilted Kootenay beds dipping to a fault-plane, and partially overridden by the limestones of Cascade mountain. These measures are being mined at Bankhead by entries from the Cascade valley. The coal is mostly anthracitic and approaches anthracite in the part opposite Banff.

PALLISER.

This area, situated east of the Cascade coal-field, on a branch of the Red Deer river, contains about 6 square miles. A 5-foot seam is known, dipping west toward the Palliser range, which is a block of Devono-Carboniferous strata, faulted and pushed up, probably, over the Cretaceous.

COSTIGAN.

The measures in this field occupy a triangular basin the western edge of which is composed of the upturned beds. The measures are thinner here than in the area to the west, and the conglomerate which marks the top of the formation is present, with some of the Dakota formation also. The sketch in Figure 8

illustrates the attitude of the beds and the general position of the seams, which lie in the lower part of the measures. In the outcrops, at the eastern edge of the basin, five seams are

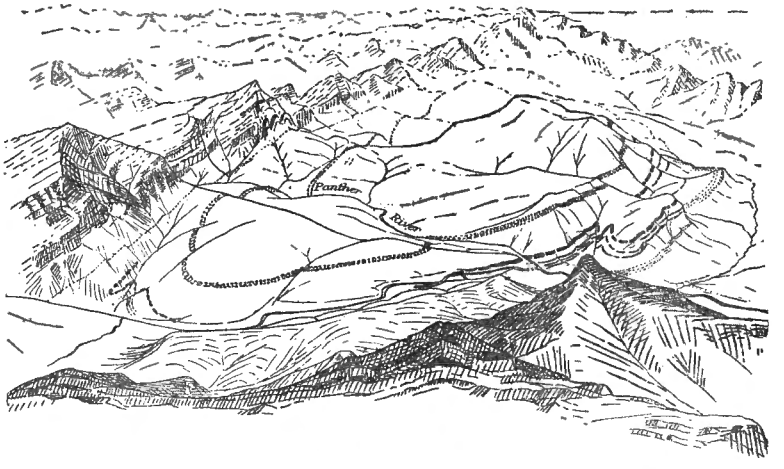

Figure 8. Sketch of Costigan coal-field.

found, aggregating 18 feet of coal. On the upturn at the west, the coal content is 26 feet and four seams are of mineable thickness. On the most easterly outcrop only one mineable seam appears.

RAM CREEK.

Kootenay measures have been found in bands crossing this stream, but no detailed examination of the beds has yet been made. Two bands or strips occur within the mountains and another at the fault line outside the first range; a fourth, probably a continuation of measures brought up by the Brazeau Hills fault and anticline, is being mined at the Saskatchewan. It is known as the Shunda Creek basin.

BIGHORN.

This coal-field consists of a large block of Lower Cretaceous measures, uptilted on its eastern margin. The western border is a fault line along which the succeeding mountain ridge is

pressed against uptilted beds of the Cretaceous basin. The coal-bearing rocks in the western part, where upturned, are in a very crushed condition, the mineable areas occurring along the eastern outcrop and in cross valleys. The width of the basin from the eastern outcrop to the fault line averages about 7 miles, and at the middle of the syncline the coal horizon would be at depths below those possible for mining. The basin extends from the south side of the Saskatchewan valley, north, to the north branch of the Brazeau river, a distance of 46 miles. G. S. Malloch, who mapped the southern part, has estimated that in a length of 30 miles there are 87 square miles of mineable land with a coal reserve of 6,600,000,000 tons. The ascertained coal content at a number of places is as follows:—

Bighorn river, south end of basin..... 9 seams, 52 feet.
Wapiabi creek, north of above basin..... 3 seams, 22 feet.
George creek, north of above basin.....14 seams, 88 feet.
Blackstone creek, north of above basin..... 9 seams, 66 feet.
Chungo creek, near north end..... 6 seams, 26 feet.

A 20-foot seam has been opened on the Brazeau river, where the measures cross the main stream, and a few small seams are found on the north branch.

The coal is a bituminous, coking coal of good quality. The following are analyses of outcrop samples:—

Locality.	Seam.	Moisture.	Vol.	F.C.	Ash.	Sulphur.	B.T.U.	Coke.
	ft. in.	%	%	%	%	%		
Bighorn river.....	4 6	0·99	23·17	68·24	7·60	0·57	13,448	Firm
Bighorn river ...	6 0	0·87	21·47	70·39	7·27	0·66	13,721	Firm
Wapiabi creek...	5 2	0·96	30·80	64·88	3·36	....	.....	Firm
Near Blackstone creek	14 5	1·85	26·99	62·79	8·37	0·45	12,456	Friable
	11 8	1·05	22·59	68·99	7·37	0·47	14,146	Firm
	5 9	1·18	23·18	71·08	4·56	0·52	14,068	Firm
Chungo creek...	6 7	1·04	22·61	68·89	7·46	....	.....	Firm

SHUNDA CREEK.

An upthrust of limestone crossing the North Saskatchewan river in front of the Bighorn range, has beds of the Kootenay exposed on its western slope. The beds outcrop for an unknown

distance and apparently form a basin. The dip at the eastern edge is about 20 degrees. Four seams are found, 7, 14, 7, and 4 feet in thickness, a total of 32 feet. Mining operations are being inaugurated and a railway from the east is under construction.

NIKANASSIN.

The measures in the Nikanassin basin are a continuation of those in the Bighorn, and extend from the north branch of the Brazeau river to the headwaters of the McLeod river. A fault crosses the range diagonally and the trend of the northern part of the basin is deflected to nearly west. The measures have been prospected at the south end and are known to contain three workable seams, 5 feet, 3 feet 10 inches, and 7 feet thick, respectively. Near the middle, where the fault divides the field, five seams, aggregating 44 feet, are found. The western end is narrowed by a fault, the extreme end being crushed and broken. Seams of 21 feet, 7 feet 6 inches, and 4 feet 6 inches, are found in the undisturbed part.

WEST OF MCLEOD RIVER.

An anticline of the Kootenay rocks outcrops southeast of Folding mountain on the west fork of the McLeod river. This is possibly a continuation of the Folding Mountain anticline which crosses Brulé lake on the Athabaska. On the eastern limb, where the dip is about 70 degrees, seams are reported having the following thicknesses—2 to 3 feet, 8½ feet, 4 feet, and 28 feet. On the western limb the same seams occur, including a 50-foot seam which is probably a continuation of the two lower ones of the eastern limb.

The areal extent of the measures has not been ascertained, consequently the amount of reserve is estimated only for the field prospected by private companies. The coal is reported to be bituminous, with about 65 per cent fixed carbon and 20 per cent or more of volatile matter.

FOLDING MOUNTAIN.

Folding mountain is made up of Devonian and Carboniferous limestone, forming an unbroken anticlinal dome. The eastern limb of the anticline is possibly bounded by a fault of small throw, but a small patch of Lower Cretaceous rocks is exposed, and in this nearly vertical seams of 12 feet, 4 feet, 2 feet, and 6 feet, have been traced.

BRULÉ LAKE.

The anticline of Folding mountain pitches northwest and in front of Bulrush mountain which forms the outer edge of the Rockies, at Brulé lake, the lowest beds exposed are of the Kootenay formation. In these beds, seams of 10 feet, 12 feet, and 5 feet have been found. No mining is being done, but a railway crossing the coal-field is under construction. The northern limit of the field is not ascertained, but, from the general topography, it is probable that it extends into the foothills as far as Smoky river, and is closely connected with another area within the mountains on Moose creek. The mountains separating these two fields at the Athabaska, become lower to the north, consequently the coal-beds, which overlie the limestones forming the ranges, may continue in that direction and may join those of the Brulé Lake northern extension.

ROCHE MIETTE AND MOOSE CREEK.

The fault-block, referred to above as separating this area from the Brulé Lake coal-field, is deformed by folding and minor faults. In the overlying beds containing coal, similar folds and faults occur and the field is partially divided at the south end by a fault which becomes a compound fold near the Athabaska. This apparently decreases to the north and there are, on the south side of the Athabaska, two fields in which mining operations may be carried on—a synclinal trough and a monoclinal block with a westward dip. The western portion is being mined at Pocahontas. North of the Athabaska, seams have been exposed in the valley of Moose creek and along the Athabaska.

BAPTISTE RIVER.

In the small area at the head of Baptiste river (indicated on the map) the coal-bearing rocks are exposed in a synclinal trough in which six or seven seams, ranging from 2 to 4 feet in thickness, occur. At another locality on the same watershed, a seam 16 feet thick has been discovered.

MUSKEG RIVER.

On Muskeg river just in front of the outer range of the mountains, coal-bearing beds occur in several anticlinal folds, and three seams are known, 11 feet 6 inches, 25 feet, and 7 feet in thickness, respectively.

UNEXPLORED AREAS.

Although the very thick deposits of the Kootenay formation thin out to the northeast, they have been found to be coal-bearing north of the Athabaska river, and beds of similar age in northern British Columbia are also coal-bearing; it is probable, therefore, that the foothills of the Rocky mountains, beyond the boundary between the provinces of Alberta and British Columbia, may contain valuable coal-fields. The larger part of the area in British Columbia is unexplored, but in Alberta discoveries of coal have been made that carry the known exposures of Kootenay coals to near this boundary line.

Summary of Investigations by Department of Mines of Samples of Kootenay Coal.

Analyses.

Locality.	Moisture.		Proximate Analysis of Dry Coal.			Ultimate Analysis of Dry Coal.					
	Mine	Air dried	Vol.	F.C.	Ash	C.	H.	S.	N.	O.	B.T.U. Dry coal
	%	%	%	%	%	%	%	%	%	%	
Coleman, No. 2 seam	2·0	0·7	25·1	55·1	19·8	68·5	4·0	0·4	1·0	6·3	11,720
Coleman, No. 4 seam	2·0	0·6	23·9	59·9	16·2	72·6	4·3	0·6	1·0	5·3	12,530
Passburg, Leitch colliery	1·9	1·0	27·0	55·1	17·9	70·0	4·4	0·6	1·0	6·1	12,240
Hillcrest, Hillcrest colliery	3·0	1·3	29·3	55·4	15·3	70·4	4·2	0·6	1·0	8·5	12,460
Hillcrest, Bellevue colliery	0·9	0·2	27·6	56·9	15·5	71·5	4·3	0·8	1·0	6·9	12,380
Cascade coal-field											
Canmore mine	1·2	0·9	17·2	70·5	12·3	74·6	3·8	0·8	1·6	6·9	13,210
Bankhead mine—Buckwheat	1·1	0·5	12·6	73·3	14·1	76·6	3·6	0·6	1·0	4·1	13,080
Bankhead mine—Pea coal	1·0	0·5	12·6	71·5	15·9	76·0	3·7	0·6	0·9	2·9	12,670
Bankhead mine—Coal dust briquette	2·7	0·9	17·1	68·6	14·3	76·3	3·7	0·6	1·0	4·1	13,100

Source of Coal.	Cal. value of coal per lb. as fired. B.T.U.	Moisture in coal as fired. %	Ash and clinker for dry coal. %	Equivalent evaporation per lb. as fired. %
Coleman No. 2 seam	11,630	0·8	18·8	7·17
" washed	12,690	3·7	10·6	7·60
Leitch colliery	12,130	0·9	17·0	6·61
Hillcrest colliery	12,360	0·8	15·5	7·63
" " washed	12,900	3·8	9·5	7·77
Bellevue colliery	12,280	0·8	14·1	7·41
" " washed	12,510	3·6	10·5	7·40
Cascade coal field				
Canmore mine No. 1	13,100	0·8	15·6	7·74
" " washed	13,780	4·3	8·9	8·44
Bankhead mine mixed coal	13,000	0·6	15·6	7·30
" " washed	13,590	2·7	9·5	8·20
" briquettes	13,010	0·7	15·2	7·27

Coking Tests.

Source of Coal.	Age of sample in months.	Type of oven.	Time of coking in hrs.	Remarks.	Class of coke.
Leitch colliery, No. 1. Passburg, Alberta	5½	Otto-Hoffman at Sydney	48	Little or no shrinkage, good strong coke from top to bottom.	+ B
" " " " "	5½	Bernard at Sydney Mines	48	Slightly more fragile than Otto-Hoffman coke.	
" " " " "	½	Bernard at Lille	48	Not much shrinkage, no regular fracture, produces breeze when broken, a little visible slate.	+ B
Hillcrest colliery, Hillcrest, Alberta	8	Otto-Hoffman at Sydney	48	Bright, good looking coke but very friable.	+ B
" " " "	8	Bernard at Sydney Mines	48	Like corresponding Otto-Hoffman coke.	
" " " "	½	Bernard at Lille	48	Not much shrinkage and very little fracture, irregular fracture producing breeze when broken, fairly hard coke contains visible slate.	− A
" " " "	½	Beehive at Coleman	74	Slight shrinkage, fracture fair but coke very easily broken; colour bright at top but dull at bottom, rather large amount of visible slate.	+ B
Bellevue colliery, No. 1 seam, Blairmore, Alberta	8	Otto-Hoffman at Sydney	48	Good strong tough coke.	+ B
" " " " " "	8	Bernard at Sydney Mines	48	Not so good as the corresponding Otto-Hoffman coke.	
" " " " " "	½	Bernard at Lille	48	Fairly compact and strong coke, not much shrinkage, no regular fracture, makes breeze when broken.	+ B
Lille colliery, No. 1 seam.....	8	Otto-Hoffman at Sydney	48	Friable coke with a good deal of breeze.	B

Coking Tests—Continued.

Source of Coal.	Age of sample in months.	Type of oven.	Time of coking in hrs.	Remarks.	Class of coke.
Lille colliery, No. 1 seam.....	8	Beehive at Bridgeport	72	Distinctly worse than the corresponding Otto-Hoffman coke.	
" " " "	8	Bernard at Sydney Mines	48	Similar to corresponding Otto-Hoffman coke.	
" " " "	½	Bernard at Lille	48	Fair shrinkage and fair fracture but friable coke and, therefore, it produces breeze; contains visible slate.	+ B
Dennison colliery, No. 2 seam, Coleman, Alberta	8	Otto-Hoffman at Sydney	48	Medium hard coke, breaks up rather easily but without producing much breeze.	B
" " " " "	8	Beehive at Bridgeport	72	Dirty friable coke, not properly banded.	
" " " " "	½	Bernard at Lille	48	Not much shrinkage, fracture irregular, makes a lot of breeze and contains a good deal of visible slate.	− B
" " No. 4 " "	8	Otto-Hoffman at Sydney	48	Fairly hard coke, but cleavage not very regular.	+ B
" " " " "	½	Bernard at Lille	48	Slight shrinkage, no regular fracture, a lot of visible slate.	B
" " " " "	½	Beehive at Coleman	74	Not much shrinkage, no regular fracture, a good deal of visible slate, fair colour at top.	+ B
No. 1 mine, Canmore, Alberta.....	8½	Otto-Hoffman at Sydney	48	Coal very little changed, a few traces of sintering.	D
Bankhead colliery, Bankhead, Alberta...	8½	"	48	Coal hardly any change in appearance.	D

A = Good commercial coke − subdivided + A, A, − A.
B = Poor " " " + B, B, − B.
C = An agglomerate, not commercial coke—subdivided + C, C, − C.
D = Non-agglomerating.

Gas Producer Tests.

DESCRIPTION.	No. 2 seam Denison colliery, Coleman, Alberta.	Leitch colliery Passburg, Alberta.	No. 1 mine, H. W. McNeil Co. Ltd., Canmore, Alberta.	Mixed Pea and Buckwheat, Bankhead Mines, Ltd., Bankhead, Alberta.
Volatile matter %	24·4	29·2	16·7	11·4
Ash %	18·1	18·7	12·3	9·9
Moisture %	1·1	1·0	0·7	1·0
Cal. value of coal as charged. B.T.U.	11590	12120	13120	12950
" " gas (lower) per cub. ft. B.T.U.	97·3	103·9	87·2	102·1
Producer efficiency	0·529	0·397	0·600	0·598
Coal per B.H.P. per hr. lbs.	2·14	2·74	1·72	1·78
Caking of coal	Cakes slightly	Cakes considerably	None	None
Average interval between poking	2½ hrs.	55 mins.	3½ hrs.	8 hrs.
Clinker	No trouble	Troublesome	Very little, gave no trouble	No trouble
Tar	45 lbs.	26 lbs.	20 lbs.	6 lbs. from scrubber (gas washer not used).
Uniformity in gas quality	Rather variable	Not very uniform	Fair	Very uniform
Amount of steam used	Moderate	Moderate	Large	Large
Combustible in refuse	Low	Moderate	Low	Low
Remarks	No trouble from tar, fairly suitable for producer work	Scrubbers and washers did not completely remove tar, which was sufficient to render engine valves sticky. Coal needed much attention in producer	Worked well but gave gas of very poor calorific value, no trouble, good producer coal	Fire quite free, coal worked well, no trouble

SUMMARY OF COAL RESOURCES, KOOTENAY FORMATION, ALBERTA.

GROUP I.

INCLUDING SEAMS OF 1 FOOT OR OVER, TO A DEPTH OF 4,000 FEET.

DISTRICT.	COAL-SEAMS.		ACTUAL RESERVE (Calculation based on actual thickness and extent).			PROBABLE RESERVE (Approximate estimate).		
	No.	Thickness	Area in square miles	Class of coal	Metric tons	Area in square miles	Class of coal †	Metric tons
Head of south fork Oldman	1	10 feet	.....	.....	.....	5	B_2	50,000,000
Coleman	6	Aggregate 38 feet	.....	.....	.....	30	B_2	1,000,000,000
Blairmore-Frank	6	Aggregate 50 to 57 feet	.....	.....	.....	90	B_2	4,500,000,000
Livingstone	1	Aggregate 10 feet, Storm creek	.....	.....	.....	21	B_2	230,000,000
Livingstone	13	Aggregate 43 feet, Mist and Sheep creeks	.....	.....	.....	22	B_1, B_2	1,000,000,000
Livingstone	17	Aggregate 43 to 125 feet, Highwood and Livingstone	.....	.....	.....	300	B_2	25,000,000,000
Kananaskis watershed	2	Aggregate 10 and 12 feet	.....	.....	.....	9	B_2	90,000,000

† For classification see Preface.

SUMMARY OF COAL RESOURCES, KOOTENAY FORMATION, ALBERTA—(*Continued*).

GROUP I.

INCLUDING SEAMS OF 1 FOOT OR OVER, TO A DEPTH OF 4,000 FEET.

DISTRICT.	COAL-SEAMS.		ACTUAL RESERVE (Calculation based on actual thickness and extent).			PROBABLE RESERVES (Approximate estimate).		
	No.	Thickness	Area in square miles	Class of coal†	Metric tons	Area in square miles	Class of coal†	Metric tons
Cascade								
Kananaskis	10	Aggregate 50 feet	2½	A_2 B_1	68,000,000			
Kananaskis divide	20	Aggregate 80 feet	3½	A_2 B_1	97,000,000			
Kananaskis divide	25	Aggregate 100 feet	8	A_2 B_1	890,000,000			
Marsh-Mine hill	26	Aggregate 106 feet	3	A_2 B_1	325,000,000			
Canmore to Three Sisters	8	Aggregate 38 feet	2	B_1	57,000,000			
Canmore to Bankhead	5	Aggregate 25 feet	11	A_2 B_1	174,000,000			
Bankhead north	12	Aggregate 60 feet	3	A_2 B_1	200,000,000			
North of Bankhead area	6	Aggregate 40 feet	.....	.....	.....	3	A_2	100,000,000
Panther Creek	2	Aggregate 7 feet	.....	.....	.....	2	B_2	17,000,000
Red Deer north	24	Aggregate 114 feet	.....	.....	.....	9	B_1, B_2	850,000,000
Moose mountain	3	Aggregate 15 feet	.....	.....	.....	12	B_2	200,000,000
Palliser	2	Aggregate 5 and 2 feet	.....	.....	.....	6	B_2	30,000,000
Costigan	5	Aggregate 18 feet	.....	.....	.....	12	B_1	90,000,000
Ram creek	1	Aggregate 4 feet	.....	.....	.....	5	B_2	*5,000,000
Bighorn. General estimate by Malloch, less areas prospected	.....	.....	.....	.....	.....	74	B_1 B_2	5,500,000,000

† For classification of coals see Preface.
* Possible reserve—large.

SUMMARY OF COAL RESOURCES, KOOTENAY FORMATION, ALBERTA—(*Continued*).

GROUP I.

INCLUDING SEAMS OF 1 FOOT OR OVER TO A DEPTH OF 4,000 FEET.

DISTRICT.	COAL-SEAMS.		ACTUAL RESERVE (Calculation based on actual thickness and extent).			PROBABLE RESERVES (Approximate estimate).		
	No.	Thickness	Area in square miles	Class of coal†	Metric tons	Area in square miles	Class of coal†	Metric tons
Saskatchewan	2	Aggregate 13 feet	½	B_2	10,800,000			
Bighorn	6	Aggregate 42 feet 10 inches	5	B_2	140,000,000			
Wapiabi	3	Aggregate 20 feet	1	B_2	26,000,000	.....	.....	25,000,000
Smith creek	3	Aggregate 20 feet	1	B_2	17,000,000	.....	.....	17,000,000
Blackstone	8	Aggregate 60 feet	4	B_2	198,000,000			
Chungo	3	Aggregate 26 feet	2	B_2	43,000,000	.....	.....	40,000,000
Shunda	3	Aggregate 32 feet	5	B_2	160,000,000	15	B_2	1,000,000,000
North and South	.....	.....	.....	.....	.....	.....	B_2	*1,000,000,000
Main Brazeau	4	Aggregate 35 feet	6	B_2	120,000,000	.....	B_2	90,000,000
	3	Aggregate 15 feet	.....	.....	.....	8	B_2	400,000,000
Nikanassin	5	Aggregate 44 feet	3	B_2	105,000,000	Below 1,000 ft.	B_2	105,000,000
	5	Aggregate 20 feet	.....	.....	.....	Same area.	B_2	50,000,000
	3	Aggregate 33 feet	.....	.....	.....	9	B_2	290,000,000
	3	Aggregate 15 feet	4	B_2	34,000,000	8	B_2	120,000,000
West fork McLeod	4	Aggregate 42 feet	.....	.....	.....	10	B_2	210,000,000
Folding mountain	4	Aggregate 24 feet	½	B_2	31,000,000	2	B_2	70,000,000
Brulè lake	3	Aggregate 25 feet	.....	.....	.....	8	B_2	260,000,000
Roche Miette	3	Aggregate 30 teef	.....	.....	.....	6	B_2	200,000,000
	2	Aggregate 15 feet	.....	.....	.....	3	B_2	15,000,000

*Possible reserve—Large.

†For classification of coal see Preface

SUMMARY OF COAL RESOURCES, KOOTENAY FORMATION, ALBERTA—(*Continued*).

GROUP I.

INCLUDING SEAMS OF 1 FOOT OR OVER, TO A DEPTH OF 4,000 FEET.

DISTRICT.	COAL-SEAMS.		ACTUAL RESERVE (Calculation based on actual thickness and extent).			PROBABLE RESERVES (Approximate estimate).		
	No.	Thickness	Area in square miles	Class of coal†	Metric tons	Area in square miles	Class of coal†	Metric tons
Moose creek	5	Aggregate 22 feet	.....	.....	.....	3½	B_2	65,000,000
	2	Aggregate 11 feet	.....	.....	.....	2	B_2	4,600,000
	6	Aggregate 43 feet	.....	.....	.....	12	B_2	240,000,000
	3	Aggregate 25 feet	.....	.....	.....	12	B_2	100,000,000
Head of Baptiste	6	Aggregate 15 feet	.....	.....	.....	10	B_2	147,000,000
Head of Muskeg river	3	Aggregate 43 feet	.....	.....	.....	3	B_2	12,000,000
				B_2	884,800,000	.....	B_1, B_2	43,022,600,000
				B_1	1,142,000,000	.....		
				A_2	669,000,000	.....	A_2	100,000,000
Totals	....	.....	65	.....	2,695,800,000	711½	.....	43,122,600,000

* Possible reserve—Large.

† For classification of coal see Preface.

GROUP II.

INCLUDING SEAMS OF 2 FEET AND OVER, AT DEPTHS BETWEEN 4,000 AND 6,000 FEET.

DISTRICT.	COAL-SEAMS.		PROBABLE RESERVES (Approximate estimate).		
	No.	Thickness	Area in square miles	Class of coal	Metric tons
Coleman	6	38 feet	6	B_1	200,000,000
Blairmore	6	50 feet	10	..	500,000,000
Livingstone	17	75 feet	70	..	5,800,000,000
Bighorn	8	60 feet	97	B_1	5,500,000,000
Main Brazeau	2	35 feet	3	..	130,000,000
Nikanassin	3	15 feet	6	..	170,000,000
	5	40 feet	6	..	300,000,000
In Jasper park	2	20 feet	5	..	100,000,000
Totals	.....	.....	203	.....	12,700,000,000

CHAPTER VII.

BRITISH COLUMBIA.

(See Map 129A in pocket.)

INTRODUCTORY.

The important coal-bearing rocks of British Columbia are of Cretaceous age; the areas are not continuous as they are in Alberta, but are more or less isolated and must be correlated mainly on fossil evidence. The measures are in many cases of great thickness and are coal-bearing in at least two distinct stages; the lower and older stage including the coal measures of the Crowsnest and Elk River fields in the Rocky mountains and probably those of Queen Charlotte islands; and the upper including the coal measures of Nanaimo and Comox and probably those of Suquash and Quatsino sound. The coal is generally bituminous though partly altered to anthracite in several localities through local disturbance of the beds.

Many basins filled by sedimentary deposits of Tertiary age are distributed throughout the province. In some of these, lignite beds of excellent quality are found. Outflows of igneous material have partly covered these deposits and the consequent alteration of portions of the beds has produced valuable steam coals. The exact geological ages of the measures in many of the fields are uncertain, as they are known only by a few outcrops of coal-seams; they are, therefore, arranged geographically in the descriptions which follow, grouped under:—

Southern British Columbia.
Central British Columbia.
Northern British Columbia.
Vancouver island.
Queen Charlotte islands.

Coal Resources of British Columbia

GROUP I.

Including Seams of 1 Foot or Over to a Depth of 4,000 Feet.

District.	Actual Reserve.			Probable Reserve.		
	Area square miles	Class of coal†	Metric tons	Area square miles	Class of coal†	Metric tons
Southern interior	230	B_2	22,586,342,000	216	B_2	32,491,000,000
					B_3	296,000,000
					C	1,800,000,000
					D	286,000,000
Central interior	.....	.....	.....	25¾	B	34,700,000
					B_2	432,000,000
					B_3	20,000,000
Northern interior	.....	.....	.....	5,114	A_2	1,200,000,000
					B_2	1,550,000,000
					B_3	1,600,000,000
					D	3,850,000,000
Vancouver island	185	B_2	1,060,000,000	645	B_2	4,807,000,000
		B_3	118,000,000	.....	B_3	384,000,000
Queen Charlotte islands	22	A_2	6,900,000	59	A_2	293,000,000
		B_2			B_2	
	2	D_2	60,000,000	136	D_2	1,000,000,000
Totals	439	.....	23,831,242,000	6,195¾	.....	50,043,700,000
						23,831,242,000
Total coal, Group I	.....	.....	.....	.....	.....	73,874,942,000
Total coal, Group II	.....	.....	.....	.....	.....	2,160,000,000
Total for British Columbia to 6,000 feet	.....	.....	.....	.....	.....	76,034,942,000

†For classification of coal see Preface.

Approximately the grades of coal as given in the Preface, represented in the British Columbia reserve, may be arranged as follows:—

GROUP I.

INCLUDING SEAMS OF 1 FOOT OR OVER, TO A DEPTH OF 4,000 FEET.

A_2	1,349,950,000	metric tons.
B	34,700,000	"
B_2	63,076,292,000	"
B_3	2,418,000,000	"
C	1,800,000,000	"
D	4,136,000,000	"
D_2	1,060,000,000	"
	73,874,942,000	"

GROUP II.

INCLUDING SEAMS OF 2 FOOT OR OVER, TO A DEPTH OF 4,000 FEET.

Southern British Columbia, 11 square miles, B_2, 2,160,000,000 metric tons.

SOUTHERN BRITISH COLUMBIA.

FLATHEAD RIVER.

The Kootenay formation (Lower Cretaceous) which contains the valuable coal deposits of the Rocky mountains attains its greatest thickness on Elk river. Outliers are found on Flathead river, the largest occurring on the west side of the valley about 12 miles north of the International Boundary. A series of low, wooded hills surrounded by limestone mountains forms a basin of small extent that may be a fault-block. The eastern outcrop shows beds dipping west 20 degrees, and seams 20 feet, 30 feet, 16 feet, and 50 feet thick, are exposed. This area is now being prospected and promises to prove a valuable field though it may be broken by faults or folds. The coal is bituminous and apparently clean.

Farther north in the valley, between limestone mountains, a block of similar rocks is found on edge and has been traced by following a 50-foot seam for about 2 miles; but owing to the nearly vertical attitude of the seam, this area will not

produce as much coal as the first mentioned locality. A third outlier occurs near the North Kootenay pass in the form of a narrow strip of northerly dipping coal-beds, cut off or upturned on the north against an upthrust limestone block. Several seams have been found in the belt.

CROWSNEST.

(See Map 130A in pocket.)

This field contains the most important body of coal that is being mined in the province. It is in basin form, covering an area of 230 square miles, surrounded by uplifted lower beds. Some faulting occurs in the basin but most of the disturbed beds, at the outer margin near the lines of uplift, have been deeply eroded, so that the measures now seem to occupy an elevated plateau.

Most of the heavy seams occur in the lower 2,000 feet of the measures. At Sparwood mountain, near Michel, a further thickness of 2,000 feet in the upper part of the measures contains a number of thin seams, mostly cannel or coal having a high percentage of volatile matter. The Morrissey section at the south gives a thickness of 3,700 feet of coal-bearing beds. The covering beds are mostly coarse sandstones and conglomerates and are of great thickness.

The coal content, in natural sections at a number of places, including only seams over 1 foot thick, is as follows:—

At Morrissey 23 seams give 216 feet of coal in 3,676 feet of measures.

At Fernie 23 seams give 172 feet of coal in 2,250 feet of measures.

At Sparwood 23 seams give 173 feet of coal in 2,050 feet of lower measures.

At Sparwood 24 seams give 43 feet of coal in 2,015 feet of upper measures.

The seams shown in the upper measures in the Morrissey section thin out before reaching Fernie, but at Fernie there seems a possibility that there may be other lower seams that are not included in the section, so that the basin appears to have

a fairly constant coal content of nearly 172 feet in 23 seams, with, possibly, an additional 40 feet contained in the thin seams of the upper measures. The mines at present operating lie along the railway; they are: *Michel*, situated in the valley of Michel creek; *Hosmer*, on the western edge of the basin; *Coal Creek*, near Fernie in the valley of Coal creek; *Morrissey*, situated in the valley of Morrissey creek; and *Corbin*, situated on an eastern outlier.

The seam worked at Corbin occupies a synclinal trough pitching to the north. The trough occupies the western part of the hill and the eastern edge appears to be sharply folded downward to the east. About 80 feet of coal is found in this seam where it has been prospected along the horizontal outcrop. The seam is faulted and buckled as shown in the north face of the hill where a mass of coal is being mined by a series of tunnels. The basin at the top of the hill has little cover over the coal at its south end and an area there, with coal 125 feet thick, is being stripped and will be mined by steam shovel and shipped by a switchback railway descending the hill on the west side.

UPPER ELK RIVER.

North of the Crowsnest coal-area, the mountains are disposed in ridges corresponding to the axes of narrow, parallel fault-blocks, with a generally north and south alignment. The eastern boundary of British Columbia follows the upturned eastern edge of one of these blocks from the Crowsnest pass northward to the head of Elk river, and the rocks exposed on its westward slope consist of limestones and quartzites of Carboniferous and Permian age. On the lower slopes, the Triassic red shales and Jurassic dark shales are seldom seen, although probably present. The character of the topography indicates that the Lower Cretaceous sandstones containing the coal-bearing beds of the Kootenay formation, form a long narrow strip in the valley. The north end is probably overridden by the limestones of the next succeeding block. At the south, an upturn near the fault on the west seems to indicate the occurrence of a syncline which probably continues north for over half

the length of the block. Toward the centre the basin widens and includes an area of the same measures capping an easterly-dipping, contiguous block to the west, known as the Green Hills area, thus forming apparently a wide syncline.

The measures here are continuations of those of the larger coal-field to the south, but only in places are the whole of the coal-bearing beds known to be present. At the south end there are about twelve seams with 80 feet of coal. On Lewis creek eight seams are reported, one of which is 31 feet thick. At Aldridge creek, seven seams, having 68 feet of coal, were explored by tunnels, and on the eastern face of the hill eighteen seams with 182 feet of coal were found in a thickness of 1,200 feet of the measures. The western or Green Hills section contains ten seams with 97 feet of coal. The area is, therefore, a valuable one and contains a large reserve. Assays show the coal to be very similar in character to the coals from the Crows-nest field.

BULL RIVER.

Loose pieces of lignite have been found at the mouth of this stream on Kootenay river and indicate a possible Tertiary outlier in the valley.

NORTH FORK OF KETTLE RIVER.

A small Tertiary outlier has been found at the head of this stream, west of Arrow lake, but the seams so far found are not of economic importance.

MIDWAY.

Two small areas of Tertiary rocks in which some coal has been found, occur near Midway. Another area is reported on Rock creek near Kettle river. As the areas are small, and mineable seams have not been reported, the available reserve of coal is unknown.

OKANAGAN.

Small areas of Tertiary rocks occur west of Okanagan lake, but development work has been done only near Park hill at White Lake post-office, where a shaft was sunk on a 2-foot seam. The character of the coal is shown in the following analysis:—

Moisture	1·59%
Volatile matter	33·95
Fixed carbon	55·36
Ash	9·10

Small seams are reported to occur at Trout creek also, near the southern end of Okanagan lake.

PRINCETON.

In the valley of Similkameen river at Princeton, Tertiary coal-bearing rocks occupy a depression in Palæozoic and possibly Mesozoic strata. This basin is reported by Charles Camsell, of the Geological Survey, to contain an important reserve of coal. The formation is thus described:—

"*Oligocene.* These sedimentary rocks alone in the northern part of the district cover an area of nearly fifty square miles the basin being fourteen miles long with a variable width of from three to five and a half miles. They consist of thick beds of sandstone, with clay, shales and several seams of lignite. The base of the series appears to be a very coarse-grained sandstone containing many large, rounded, white feldspars in a matrix of calcareous material. This rests on the eastern side of the basin of the Copper Mountain series of rocks, while on nearly all other boundaries the sediments dip under the more recent volcanic rocks which lie as sheets on them. In parts also these volcanics have thrust themselves through the sediments and now appear as islands in the older rocks. The strata do not now lie horizontally but have been tilted at low angles, making an irregular series of folds. Some faults also occur."

The coal is not distributed in seams that can be correlated, but the formation contains a workable seam. Borings in different parts of the basin have shown the following seams: at Princeton three seams, 4 feet 6 inches, 6 feet 7 inches, and 18 feet 5½ inches thick, occur within 50 feet of the surface. One and a half miles up the river seams of 5 feet, 1 foot 7 inches, and 3 feet, occur between 200 and 240 feet of the surface. At 2 miles above Princeton, thin seams occur at these depths and a seam 10 feet 7 inches thick lies at a depth of 676 feet. Near the western border, where possibly higher beds occur, seventeen seams were found, having an aggregate thickness of 50 feet 6 inches, and an outcrop of 80 feet of coal is also known. The 18-foot seam at Princeton contains lignite having the following composition:—

Moisture	16·17%
Volatile matter	37·58
Fixed carbon	41·67
Ash	4·58

TULAMEEN.

The coal basin is situated on the hills to the south of the town of Tulameen. The following description is from the report by Mr. Camsell:—

"The coal basin is almost circular and is occupied by sandstones, shales, clays and coal-seams. These rest conformably on volcanic rocks consisting of agglomerates, basalts and andesites and are in part covered by more recent volcanic flows. The rocks have been tilted at low angles, and on the outer borders of the basin appear to dip toward the centre. The angles are never more than 45 degrees and are generally less. Small folds appear on Collins gulch and in other places minor faults occur, but on the whole the disturbance is probably not great enough to seriously affect the mining of the coal.

"The rocks are determined from their fossils to be Oligocene in age, and in consequence they are correlated with the coal basins of Princeton, Nicola, Kamloops, and with other Tertiary lake-basins of the interior of British Columbia."

Analyses of samples from the following localities:—

1. Seam, 6 feet 6 inches wide, upraise No. 2 tunnel, Granite creek.
2. Seam, 5 feet wide, from No 2 tunnel, Granite creek.
3. Seam, 6 feet wide, from face of No. 4 tunnel, Granite creek.
4. Outcrop of large seam, Collins gulch.

	1	2	3	4
Moisture.....	3·04%	4·34%	2·97%	3·26%
Volatile matter....	31·88	31·08	31·28	43·33
Fixed carbon.....	51·11	48·89	52·49	49·70
Ash.....	13·19	15·69	13·26	3·71
Character of coke.	Strong	Compact	Compact	Tender

Owing to the depth of the seams below the surface in the centre of the basin, it is probable that only an area of 5 square miles around the edge is mineable. Seams 1, 2, and 3, are on the south rim. To the north, in Collins gulch, two seams have been reported, a 12-foot seam of clean coal and a 20-foot seam with slate bands.

NICOLA AND QUILCHENA.

These two basins of Oligocene rocks occupy depressions in a series of volcanic rocks of Triassic age. The coal is highly altered and the occurrence of small patches of basalt, similar to that covering part of the field at Tulameen, shows that this area also was once covered by a similar outflow. The Nicola basin occupies depressions in two valleys at right angles to each other; a large basin on Tenmile creek is connected by a narrow valley with the basin in Nicola valley; the Quilchena basin lies about 8 miles to the east of the Nicola basin. The rocks dip toward the centre of each basin and are broken by minor faults. Superficial deposits mask all the exposures on the lower levels and are very thick in the vicinity of Nicola river. Exploration by boring shows that the heaviest coal-

seams occur near the mouth of Coldwater creek and three companies have opened collieries in that vicinity. Seams, 6 feet, 10 feet, 5 feet, and 12 feet thick, are being mined south of the river. On the north side, a 4-foot seam outcrops and a 5-foot seam has been located beneath by boring. The coal is of better grade than lignite and is used for railway purposes. Analyses of the coal are given in the table at the end of this section.

The Quilchena basin contains a small reserve about which little information is available except what may be derived from a few outcrops and from a bore-hole which penetrated ten seams with 18 feet of coal. The western portion of the Nicola field, on Tenmile creek, is known only by the occurrence of one exposure of coal 4 feet thick.

FRASER RIVER DELTA.

Rocks of Eocene age extend from Burrard inlet, south, into the State of Washington. The exposures occur almost exclusively on the ridge north of the Fraser river and represent the northern rim of an extensive basin. South of the International Boundary the group contains several seams of lignite, and in the vicinity of Vancouver lenses of dark-brown lignite are found. The area may, therefore, contain a reserve of lignite.

WOLFFSOHN BAY.

On the mainland opposite Texada island the Tertiary rocks seem to form a basin touching tide-water at its southern edge. No coal has been found in this basin, but there is a probability of its discovery.

KAMLOOPS.

A narrow basin of Miocene beds occurs at the head of Kamloops lake and extends west along the north shore of the lake to Tranquille river, whence it continues along the foot of Red plateau to Red point. On the south side of the lake it has a

length of about 5 miles. Southwest of the town of Kamloops the beds, which rest directly upon the pre-Tertiary surface, contain coal in thin seams. The floor consists of a rough surface of diabase-agglomerates upon which the Tertiary materials lie in the form of a shallow syncline following the northward slope of Coal hill. The width of the basin is probably not over three-quarters of a mile and the thickness of the measures comprised in the syncline is about 500 feet. To the north, the coal-bearing beds pass under the basaltic agglomerates composing Mount Dufferin. One seam in these beds is made up of 5 feet 10 inches of mixed shale and coal, with one layer of clean coal 1 foot thick.

HAT CREEK AND VICINITY.

This area lies in the angle between the Fraser and Thompson rivers. The drainage of the area is north and east to Bonaparte river, a tributary entering the Thompson river at Ashcroft. Hat creek cuts through a thick deposit of stratified Oligocene rocks which occur in the form of two basins. In the upper one an exposure of 68 feet of lignite has long been known in a block detached by a small landslide, but its continuation in the undisturbed measures behind has not been traced. The coal is a lignite with 8 per cent of moisture and 9 per cent of ash.

NORTH THOMPSON RIVER.

About 45 miles above Kamloops on the east side of the North Thompson river a small outlier of Oligocene rocks, a remnant of a larger area which once extended across the valley, forms a ridge at the base of the mountainous border of the valley. The length of the ridge is about 2½ miles, and, where a little stream called Coal brook cuts through it, Tertiary rocks are exposed by the removal of the thick covering of boulder clay and drift which elsewhere shrouds them. The beds appear to form a syncline nearly parallel in its main direction with the trough of the valley. The exposures are mainly on the western limb of the syncline and in a section of 148 feet three seams, each slightly over 1 foot thick, occur, dipping at a low angle to the northeast. The coal is of fairly good quality as is shown by the following analysis of an outcrop sample:—

Moisture	2·22%
Volatile matter	38·10%
Fixed carbon	46·76
Ash	12·92

A firm, bright coke was obtained in the laboratory by fast coking.

SUMMARY OF INVESTIGATIONS BY THE DEPARTMENT OF MINES, CANADA, OF COMMERCIAL SAMPLES FROM THE SOUTHERN BRITISH COLUMBIA MINES.[1]

Analyses.

District.	Moisture.		Proximate Analysis of Dry Coal.			Analysis of Dried Sample.					
	Mine	Air dried	Volatile	Fixed carbon	Ash	C.	H.	S.	N.	O.	B.T.U.
Crowsnest	%	%	%	%	%	%	%	%	%	%	%
Michel colliery No. 3 mine	1·4	0·4	24·8	62·7	12·5	75·5	4·3	0·5	1·2	6·0	13,270
" " No. 7 mine	1·9	0·7	22·6	65·5	11·9	76·5	4·5	0·4	1·2	5·5	13,360
" " " No. 8 mine	3·0	1·1	24·1	65·7	10·2	76·1	4·5	0·6	1·3	7·3	13,480
Hosmer mine, No. 2 seam	1·7	0·9	21·3	63·4	15·3	74·4	4·2	0·3	1·0	4·8	12,710
" " No. 6 seam	2·6	1·1	25·6	62·0	12·4	75·9	4·5	0·6	1·2	5·4	13,090
" " No. 8 seam	4·0	1·3	28·0	64·5	7·5	79·8	5·1	0·6	1·4	5·6	13,990
Coal Creek colliery											
No. 2 mine	2·2	1·3	26·3	64·7	9·0	79·3	4·4	0·5	1·2	5·6	13,820
No. 5 mine	1·6	0·5	24·0	65·2	10·8	77·1	4·4	0·5	1·3	5·9	13,480
Tulameen											
Granite Creek											
No. 1 opening	.....	2·3	33·7	54·0	12·3	71·6	4·8				
No. 2 opening	.....	2·3	32·4	53·6	14·0	70·1	4·4	1·9			
No. 4 opening	.....	3·2	32·1	51·9	16·0	69·4	4·3				
Nicola valley											
Middlesboro colliery, No. 1 mine	4·4	3·9	39·1	46·4	14·5	67·2	5·0	0·9	1·3	11·1	11,680
" " No. 2 mine	2·9	2·3	39·0	48·1	12·9	69·4	5·1	0·7	2·0	9·9	12,170
" " mixture of 1 and 2	4·8	.....	39·1	46·8	14·1	66·1	4·9	0·9	1·4	12·6	11,720

[1] From "An Investigation of the Coals of Canada" Mines Branch, Dept. of Mines, No. 83.

Boiler Tests.

Source of Coal.	Calorific value of coal per lb. as fired. B.T.U.	Moisture in coal as fired. %	Ash and clinker for dry coal. %	Equivalent evaporation per lb. as fired.
Crowsnest				
Michel colliery, No. 3 mine	13,180	0·7	11·4	8·06
" " No. 3 mine washed	13,610	4·9	7·4	8·16
" " No. 7 mine	13,230	1·0	12·7	8·11
" " No. 8 mine	13,350	1·0	10·0	8·24
Hosmer mines, No. 2 seam	12,570	1·1	15·3	7·84
" " No. 6 seam	12,890	1·5	16·2	7·57
Coal Creek colliery, No. 2 mine	13,680	1·0	9·6	8·66
" " No. 5 mine	13,350	1·0	10·8	8·25
Nicola Valley				
Middlesboro colliery, seams 1 and 2	11,160	4·8	14·0	6·17
" " " " washed	11,840	6·2	10·4	6·22

Coking Tests.

Source of Coal.	Age of sample in months.	Type of oven.	Time of coking in hours.	Remarks.	Class of coke.
Crowsnest					
No. 3 mine, Michel colliery, Michel, B.C.	8	Otto-Hoffman at Sydney	48	Dense, hard coke, but breaks up easily.	+ B
" " " " "	8	Beehive at Bridgeport	72	Like corresponding Otto-Hoffman coke, but softer.	
" " " " "	½	Bernard at Lille	48	Not much shrinkage, fairly regular fracture, not much breeze, good sound coke to top.	A
No. 7 " " " "	8	Otto-Hoffman at Sydney	48	Very friable coke, not properly bonded; no regular cleavage.	− B
" " " " "	8	Bernard at Sydney Mines	48	Not a commercial coke, a little had coked but most of it was a loose powder.	
No. 8 " " " "	8	Otto-Hoffman at Sydney	48	Moderately good coke.	+ B
" " " " "	8	Bernard at Sydney Mines	48	A possible commercial coke.	
" " " " "	½	Bernard at Lille	48	Dense hard coke.	A
No. 2 seam, south, Hosmer, B.C.	½	"	48	Very weak coke, no regular fracture.	+ C
No. 6 " " "	½	"	48	Good commercial coke.	A
" " " "	½	Beehive at Coleman	74	" " "	A
No. 8 " " "	½	Bernard at Lille	48	" " "	A
No. 2 mine, Coal Creek	8	Otto-Hoffman at Sydney	48	A good coke, strong under hammer	+ B
" " " "	½	Bernard at Lille	48	Good looking coke, but friable.	B
No. 5 " " "	8	Otto-Hoffman at Sydney	48	Not notably strong but makes very little breeze in handling.	+ B
" " " "	8	Beehive at Bridgepool	72	Not so strong as corresponding coke from Otto-Hoffman and Bernard ovens.	

Coking Tests—Continued.

Source of Coal.	Age of sample in months.	Type of oven.	Time of coking in hours.	Remarks.	Class of coke.
No. 5 mine, Coal Creek.....	8	Bernard at Sydney Mines	48	Breaks up rather easily but makes very little breeze.	
" " " "	½	Bernard at Lille	48	Dense good looking coke, fair shrinkage, regular fracture, does not produce much breeze.	− A
" " " "	½	Beehive at Coleman	75	Good coke, breaks rather easily into small pieces but does not produce much breeze.	A
Tulameen Area					
No. 1 opening, Granite Creek.....	½	Otto-Hoffman at Sydney	41		
" " " " (washed)..	½	"	41		
No. 2 " " "	½	"	41		
" " " " (washed)..	½	"	41		
No. 4 " " "	½	"	41		
" " " " (washed)..	½	"	41		
Nicola Valley					
No. 2 mine, Middlesboro colliery.....	8½	"	48	A trace of caking.	+ C
Mixture from Mines 1 and 2, Middlesboro colliery.....	8½	"	48	Not coked.	C

A = Cood commercial coke—subdivided + A, A, − A.
B = Poor " " " + B, B, − B.
C = An agglomerate, not commercial coke − subdivided + C, C, − C.

Gas Producer Tests.

Description.	No. 8 mine Michel colliery.	No 5 mine Coal creek.	Mixture of coal from Jewel seam No. 1 mine and a small amount from Rat Hole seam. No. 2 mine, Middlesboro colliery, Merritt, B.C.
Volatile matter %	25·1	25·6	36·9
Ash %	6·0	10·9	12·0
Moisture %	1·1	0·8	4·2
Cal. value of coal as charged. B.T.U.	13330	13370	11220
" " gas (lower) per cub. ft. B.T.U.	102·3	95·2	99·3
Producer efficiency	0·475	0·676	0·582
Coal per B.H.P. per hr. lbs.	2·23	1·53	1·98
Caking of coal	Very slight	A little	Practically none
Average interval between poking	2 hrs	3½ hrs.	4 hrs.
Clinker	No trouble	Very slight	No trouble
Tar	50 lbs.	24 lbs.	30 lbs.
Uniformity in gas quality	Fair	Very uniform	Fair
Amount of steam used	Moderate	Considerable	Moderate
Combustible in refuse	Rather high	Moderate	Low
Remarks	Worked well in producer	Very good and easy to work	Worked easily, no trouble from tar or clinker

Summary of Coal Resources of Southern British Columbia.

GROUP I.

Including Seams of 1 Foot or Over, to a Depth of 4,000 Feet.

District.	Coal-Seams.		Actual Reserve (Calculation based on actual thickness and extent).			Probable Reserves (Approximate estimate).		
	No.	Thickness	Area in square miles	Class of coal†	Metric tons	Area in square miles	Class of coal†	Metric tons
Flathead river	7	Aggregate 130 feet	.....	.....	.....	6	B_2	600,000,000
Crowsnest	23	Aggregate 172 feet	230	B_2	22,595,200,000	.....	B_2	16,250,000,000
	24	Aggregate 40 feet	.....	.....	.....	.....	C	1,800,000,000
							B_2	2,700,000,000
Upper Elk river—								
North Michel creek	12	Aggregate 80 feet	.....	.....	.....	3	B_2	46,000,000
Forks North Michel creek	1	Aggregate 6 feet	.....	.....	.....	1	B_2	6,000,000
To McInnis mountain	8	Aggregate 63 feet	.....	.....	.....	4	B_2	120,000,000
To Lewis river	10	Aggregate 80 feet	.....	.....	.....	47	B_2	3,692,000,000
Green hills	10	Aggregate 97 feet	.....	.....	.....	60	B_2	5,900,000,000
Mount Marpole	18	Aggregate 182 feet						
Aldridge creek north	21	Aggregate 150 feet	.....	.....	.....	19	B_2	3,177,000,000
Bull river (not explored)	....	.....	Small Tertiary outlier					
Midway	....	.....	Several small Tertiary outliers					
Okanagan	....	.....	" "					

Summary of Coal Resources of Southern British Columbia.

GROUP I.

Including Seams of 1 Foot or Over, to a Depth of 4,000 Feet.

District.	Coal-Seams.		Actual Reserve (Calculation based on actual thickness and extent).			Probable Reserves (Approximate estimate).		
	No.	Thickness	Area in square miles	Class of coal†	Metric tons	Area in square miles	Class of coal	Metric tons
Princeton—								
Town of	3	Aggregate 29½ feet	.....	.....	.....	1	D_1	
Tulameen river	1	Aggregate 4 feet	.....	.....	.....	1	D_1	
Sharp's bore	17	Aggregate 50½ feet	.....	.....	.....	1	D_1	
Ninemile creek	1	Aggregate 15 feet	.....	.....	.....	2	D_1	132,000,000
Summers creek	1	Aggregate 4 feet	.....	.....	.....	1	D_1	
Blakemore's bore	3	Aggregate 12 feet	.....	.....	.....	1	D_1	
General area	1	Aggregate 2 feet	.....	.....	.....	44	D_1	86,000,000
Tulameen	3	16½ to 26 feet	.....	.....	.....	5	B_3	98,000,000
Nicola—								
Coldwater	4	Aggregate 33 feet	.....	.....	.....	1		
Merritt	2	Aggregate 9 feet	.....	.....	.....	10	B_3	175,000,000
Tenmile river	1	Aggregate 4 feet	.....	.....	.....	14		
Quilchena	10	Aggregate 18 feet	.....	.....	.....	2	B_3	20,000,000
Fraser River delta (unexplored)								
Kamloops (unprospected)								
Hat creek	1	Aggregate 68 feet	.....	.....	.....	2	D_1	68,000,000
North Thompson	3	Aggregate 3 feet 10 inches	.....	.....	.....	1	B_3	3,000,000
Totals	....	.....	230	.....	22,595,200,000	226	.....	34,873,000,000

† For classification of coal see Preface.

Taking out the amount mined, the reserves are:—

B_2	Actual reserve	22,586,342,000	metric	tons.
	Probable reserve	32,491,000,000	"	"
B_3	Probable reserve	296,000,000	"	"
C	Probable reserve	1,800,000,000	"	"
D_1	Probable reserve	286,000,000	"	"
	Total, 446 square miles	57,459,342,000	metric	tons.

Amount mined to December 31, 1911:—

East Kootenay	8,371,000	metric	tons.
Nicola valley	452,000	"	"
Princeton	35,000	"	"
	8,858,000	metric	tons.

GROUP II.

INCLUDING SEAMS OF 2 FEET AND OVER, AT DEPTHS BETWEEN 4,000 AND 6,000 FEET.

DISTRICT.	COAL-SEAMS.		PROBABLE RESERVES (Approximate estimate).		
	No.	Thickness.	Area in square miles.	Class of coal.	Metric tons.
Crowsnest Pass coal-area.	40	Aggregate 216 ft.	11	B_2	2,160,000,000

Total reserve in 457 square miles, all classes, Groups I and II—59,619,342,000 metric tons.

CENTRAL BRITISH COLUMBIA.

In the valley of the Fraser river, at Alexandria, Quesnel, and Fort George, Tertiary outliers are found, but they appear to be of little economic importance. The coal at Quesnel is a poor grade of lignite and the seams are dirty. The other localities may prove to have mineable deposits, but as lignite is not in great demand, little prospecting has been done in the areas. The country between the Fraser river and the Coast range is covered, to a large extent, by Tertiary volcanics imposed on a lower, stratified, fresh-water series, which fills many of the former depressions. This lower series often contains numerous seams of lignite and coal. There is a probability, therefore, that concealed coal-fields occur in this large district.

Lignite has been found on Nazco river near Cinderella mountain and on Blackwater river, both at the bridge and in the upper canyon. On Nechako river south of Fraser lake, a 4-foot seam was discovered. On Fraser lake, near the outlet, on the south side, prospecting tunnels have been driven on small coal-seams. The rocks seem to be much disturbed by late intrusions, and, although the lignites are altered to coals, the area is not promising.

On the western edge of this Tertiary basin near the Coast range, coal has been found on a branch of Dean or Salmon river called Kohiasganko stream, where, 30 to 40 feet below the basalt, a seam of excellent lignite, 4 feet thick, occurs. Coal is also reported on one of the branches of Bellakula river.

BEAR RIVER (BOWRON RIVER).

This stream enters Fraser river east of Fort George. Coal was found in 1876 by E. Dewdney near the surveyed line of the Canadian Pacific railway. This was probably near, or in the Fraser valley and may indicate an extension of the Tertiary area found at Fort George. During the construction of the Grand Trunk Pacific railway the valley of Bear river was explored and a basin between the mountains was found which showed in one exposure, three coal-seams. These were 9 feet

2 inches, 4 feet 2 inches, and 7 feet 8 inches, making a total thickness of 21 feet of coal. The area comprising the field is estimated by Mr. C. F. J. Galloway to be 10½ square miles with a probable content of 150,000,000 tons of coal. The coal is bituminous and coking.

LIGHTNING CREEK.

G. M. Dawson records the recurrence of a 6-foot seam at a locality known as Cold Spring Home, west of the Cariboo gold region.

SKEENA RIVER.

The Lower Cretaceous coal-bearing beds of this portion of British Columbia, called the Skeena series, appear to be very nearly contemporaneous with the coal-bearing Kootenay series of the southeastern part of the province. This shows a former wide distribution of the series to the north and west. The deposit is eroded from most of the interior country, where remnants only are found in the valleys, warped into long narrow basins by the great disturbances of post-Cretaceous times. The coal is often altered by proximity to the eruptives of that date. The coal-fields on the southern tributaries of the Skeena are described below from notes and reports by Mr. W. W. Leach.

MORICE RIVER.

On the main part of this stream Cretaceous rocks occur, but little is known about them except that they contain a few small coal-seams which are hardly mineable.

Clarks Fork. A long trough of Lower Cretaceous rocks occurs in the valley of this stream. Several bore-holes have been put down and three seams appear to be persistent, with an aggregate thickness of about 7 feet of coal. Beneath the seams shown by this bore-hole, Mr. Leach found the outcrop of a 10-foot seam. The measures thus seem to hold at least 17 feet of coal. The area is not defined, but the northern end, for a distance of 3 miles, has been proved.

Goldstream (a branch of Clarks Fork). A small area of 3 square miles has exposures of three seams, 8 feet, 6½ feet, and 3½ feet. A bore-hole in the area gives 22 feet of coal. The coal is bituminous and may be coking.

Coal Creek (a branch of Goldstream). This coal-area consists of an oval basin about 1 mile long and a quarter of a mile wide. The exposures show four seams of 4 feet 2 inches, 4 feet 6 inches, 4 feet, and 7 feet 3 inches. This coal is harder than that in the Goldstream area and is probably non-coking.

TELKWA RIVER.

In an area of possibly coal-bearing rocks crossing this stream near the Bulkley river, the harder underlying rocks form a syncline and the surface deposits contain some coal mingled with fragments of sandstone. The presence of the Coal Measures is not yet proved. The first or lowest exposure of these rocks is below Goat creek, and indicates a basin 3 miles long by about one-quarter of a mile wide. No coal has been proved in the basin.

Goat Creek. An area 5 miles long by three-quarters of a mile in average width, contains three large seams, measuring 19 feet, 24 feet, and 13 feet, respectively. Prospecting tunnels have been driven on these seams and the coal is said to show coking qualities.

Cabin Creek (a branch of Goat creek). A narrow basin crosses this valley with five seams aggregating 20 feet of coal. The coal is more altered than in the wide areas and approaches the anthracitic grade.

BULKLEY RIVER.

Driftwood Creek. This area is described by Mr. Leach as follows:—

"The coal-seams occur in a comparatively small patch of Tertiary sediments—probably not more than four by two miles in extent—although its boundaries have not been closely defined. On part of the area the coal has been burned, baking the interbedded clay-shales to a whitish brick-like material.

"The Tertiary rocks are found outcropping in the valley of Driftwood creek, about two to three miles above the crossing of the Hazelton-Aldermere wagon road. An open-cut in the bank of Driftwood creek shows this section:—

"1. Grey and carbonaceous shale and a little coal..5·0 feet.
2. Fairly clean coal.....1·8 "
3. Coal and dark shale.....4·4 "
4. Dark clay-shale and a little coal.....3·6 "

"In Nos. 3 and 4 of this section, the coal and shales alternate in very narrow beds, never more than an inch or two in thickness, the shales themselves being highly carbonaceous."

Bulkley River (20 miles above Hazelton). The coal-beds of the Skeena series are here found in a rather shallow but fairly regular basin, with a total length of about 4½ miles and a maximum width of not more than 1½ miles. Eleven seams, aggregating 16 feet of coal, have been exposed by stripping. The coal is hard and finely laminated with a distinct cleavage at right angles to the bedding.

ZYMOETZ OR COPPER RIVER.

In the flat, forest-covered country at the headwaters of this branch of the Bulkley river, coal-bearing rocks of the Skeena series are known to occur in basins, but the outlines of the areas have not been determined. On one of the small streams, four seams have been uncovered, containing a total of 12 feet of coal. The engineer who explored this small area estimated that it contained 12,000,000 tons of coal.

The unprospected areas noted in the table as unexplored are supposed to contain coal of an inferior grade. The different grades of coal occur in about the following amounts:—

B_1.....	34,700,000	metric	tons.
B_2.....	432,000,000	"	"
B_3.....	20,000,000	"	"
	486,700,000	"	"

SUMMARY OF COAL RESOURCES OF CENTRAL BRITISH COLUMBIA.

DISTRICT.	COAL-SEAMS.		PROBABLE RESERVES (Approximate estimate).			POSSIBLE RESERVE.
	No.	Thickness	Area in square miles	Class of coal†	Metric tons	
Nazco river	.....	.....	Small	D_1	Unexplored	
Blackwater river	.....	.....	Small	D_1	Unexplored	
Nechako river	1	4 feet.....	Small	D_1	Unexplored	
Alexandria	.....	.....	Small	D_1	Unexplored	
Quesnel	.....	.....	Small	D_1	Unexplored	
Fort George	.....	.....	Small	D_1	Unexplored	
Fraser lake	.....	.....	Small	D_1	Unexplored	
Kohasganko river	1	4 feet.....	Small	D_1	Unexplored	
Bellakula river	.....	.....	Small	D	Reported	
Bear river (Bowron river)	3	21 feet.....	10½	B_2	150,000,000	
Lightning creek	1	6 feet.....	Small	D_1	Reported	
Concealed areas	.....	.....	.....	.....	.....	Large
Skeena river						
Morice river—						
Clarks Fork	4	Aggregate 17 feet....	3	B_2, B_3	40,000,000	
Goldstream	3	Aggregate 20 feet....	3	B_2	50,000,000	
Coal creek	4	Aggregate 19 feet....	¼	B	4,700,000	
Telkwa river—						
Goat creek	3	Aggregate 56 feet....	2½	B_1	140,000,000	
Cabin creek	5	Aggregate 20 feet....	1½	B_1	30,000,000	
Bulkley river	11	Aggregate 16 feet....	4	B_2	60,000,000	
Driftwood creek	.....	Small.....	.....	D_1		
Zymoetz river	4	Aggregate 12 feet....	1	B_2	12,000,000	
Totals	.....	.....	25¾	.....	486,700,000	

† For classification of coal see Preface.

NORTHERN BRITISH COLUMBIA.

KISPIOX RIVER.

At the mouth of this stream, on the Skeena river, there is a piece of flat country in which rocks of the Skeena series are found. The area underlain by these rocks extends up the Skeena valley for about 7 miles and up the valley of the Kispiox river for possibly a greater distance. On both streams near the ends of this basin the measures are broken and disturbed. Coal-seams are exposed on both streams—on the Skeena, 7 miles up, five seams of 2 feet, 2 feet, 5 feet, 2 feet, and 1 foot 4 inches—on the Kispiox two seams, 2 feet and 3 feet at 5½ miles from the mouth. At the junction of the two rivers the beds appear to be less disturbed than those farther up the rivers and probably carry more coal.

GROUNDHOG MOUNTAIN.

This is an important area situated on the headwaters of the Skeena, Nass, and Stikine rivers. The Skeena series, in the areas south of the Skeena river, rest on volcanics of the Hazelton group, which are probably Jurassic. To the north these volcanic flows change to tuffs deposited in water and gradually merge into sedimentary rocks. The series there becomes conformable with the Skeena, and a greater thickness of sediments is found having the coal-beds in the upper part. By faulting, these upper beds are repeated in inclined blocks, and since the upper beds are probably much eroded, the field may possibly be divided into a number of small, separate blocks.

The original area outlined by prospectors and included in surveyed lines, is nearly 170 square miles. The coal is all semi-anthracitic, and in some instances is classed as anthracite.

SUSTUT RIVER.

A small outlier, probably of Tertiary sediments, and carrying small seams of lignite, occurs on this stream near its junction with an eastern branch of the Skeena near Fort Connelly.

PEACE RIVER.

The structure of this corner of the province is a continuation of that of northern Alberta. The Edmonton coal-beds probably do not continue into British Columbia, but the Dunvegan formation on Peace river occupies a large area in both provinces. In this formation the coal-seams are thin, but in the western part of the synclinal trough in which they occur, the coals are of higher grade than in the eastern part. Seams 2 feet thick occur east of the canyon of Peace river. In the area near the canyon and on Pine river to the south, a greater number of seams have been discovered and these, although thin, are of a high grade. The section on Johnson creek west of the canyon shows nine seams over 1 foot, four seams over 2 feet, and three seams over 3 feet thick.

PARSNIP RIVER.

From the occurrence of many fragments of lignite in the bed of Parsnip river, there is reason to believe that there is a large Tertiary area in the upper part of the valley.

LIARD RIVER.

Tertiary basins are cut by the Liard River valley and tributaries and, at the mouth of Dease river and for some distance both above and below it on Liard river, Tertiary sandstones occur. At only one point in British Columbia have these measures been found to contain lignite, but in a large area in the valley of the upper Liard, extending from south of Dease river into the Yukon, a 3-foot lignite seam is known. Tertiary rocks also appear below the mouth of the Dease on Liard river and probably extend to Little canyon. A second Tertiary outlier is found on the north side of Liard river at Coal brook, where numerous fragments of coal were observed, but no seams found in place.

Other lignite areas are: (1) at Rapid river on Dease river halfway between Dease lake and Liard river where a 2-foot seam is reported; (2) on a branch of Stikine river called Tahltan, where coal is reported in Tertiary rocks.

ATLIN.

The following extracts from a report by Mr. D. D. Cairnes give all the information known of these coal-fields to date. The locations are on Taku river and its tributaries, which flows southwest to Taku inlet. Sloko lake is at the head of a western branch and is not far from the south end of Atlin lake:—

"The Wheaton River rocks extend to the east down the valley of Sloko river, the outlet of Sloko lake, for approximately two miles, where sedimentary rocks belonging to the Jura-Cretaceous Laberge series outcrop and thence continue down the valley for several miles at least. The Laberge beds occur also on the mountain slopes on the north side of Sloko river, where they extend to an elevation of 2,550 feet above Sloko lake at their most north-westerly exposure; and two and a half miles in a north-easterly direction from the north-eastern corner of the lake. Here only a narrow tongue of these rocks has been stripped, by erosion and weathering processes, of their original cover of volcanics, and is still surrounded, and overlain on three sides by flat-lying beds, which hide the remaining portions of the Laberge rocks to the north, east, and west.

"The sedimentary beds, where exposed, strike about N. 70° W., dip to the south-west at from 20° to 50° and consist mainly of dark, finely-textured shales and sandstones, but also include, near the summit of the ridge, some dark conglomerates that belong to the Tantalus conglomerates, and consist entirely of quartz chert, and slate pebbles, generally firmly cemented together. All the important coal-seams that have been found in Northern British Columbia and southern Yukon occur associated with these Tantalus conglomerate-beds.

"The uppermost portion of this sedimentary area just described is, in most places, covered by several feet of weathered and decomposed material, which is derived from the surrounding and underlying volcanics and sediments, predominantly from the volcanics, and is in the form of sand, mud, and clay; this in places, contains a certain amount of wash coal which occasionally occurs in layers more or less mixed with other products

of erosion and weathering, and near the summit of the ridge pieces of lignitic coal and carbonized wood, as much as 6 inches thick, have been found. Some of the layers of detrital coal were at first thought to be coal-seams in place."

Samples were brought by prospectors from a 4-foot seam on Taku river 12 miles above canoe navigation or about 30 miles from Juneau. Coal is also reported to occur on an eastern branch of this stream called Inklin river.

GROUP I.

INCLUDING SEAMS OF 1 FOOT OR OVER, TO A DEPTH OF 4,000 FEET.

DISTRICT.	COAL-SEAMS.		PROBABLE RESERVES (Approximate estimate).		
	No.	Thickness	Area in square miles	Class of coal†	Metric tons
Kispiox river	5	Aggregate 12 feet	14	B_2	150,000,000
Groundhog mountain	8	Aggregate 30 feet	40–170	A_2	1,200,000,000
Sustut river (unexplored)	.....	.....	.....	D_1	
Peace and Pine rivers—					
Dunvegan series	1	2 feet	4,900	B_3D_1	5,450,000,000
Peace River canyon	14	Aggregate 10 feet	160	B_2	1,400,000,000
Parsnip river (unexplored)	.....	.....	.....	D_1	
Liard river (unexplored)	.....	.....	.....	D_1	
Taku river (unexplored)	.....	.....	.....	B_2	
Totals	.....	.....	5,114	.....	8,200,000,000

† For classification of coals see Preface.

The following are the totals of the several classes of coal tabulated in the preceding table:—

A_2	1,200,000,000	metric tons
B_2	1,550,000,000	" "
B_3	1,600,000,000	" "
D_1	3,850,000,000	" "

COAL-FIELDS OF VANCOUVER ISLAND.

(*By C. H. Clapp.*)

(*See Map 131A in pocket.*)

The coals of Vancouver island are all, so far as known, of Upper Cretaceous age. They are associated with a thick series of sandstones, conglomerates, and shales called the Nanaimo series, which were deposited, largely under estuarine conditions, on the irregular, drowned portions of the pre-Upper Cretaceous erosion-surface, developed on the metamorphic and granitic rocks of the Vancouver range. The deposition took place chiefly off the east coast of the range in the down-warped basin between Vancouver island and the mainland, but some deposition occurred in broad estuaries extending inland from the northern portion of the west coast. The conditions of deposition were local and varying, as shown by the rapid lateral and vertical gradation of the sediments, and by the relative lack of persistency of the coal-seams; and, since the series contains not only marine fossils but land plants and coal, marine and terrestrial conditions must have alternated with each other. During the deposition, the sedimentation transgressed inland, at first filling up the valleys of the pre-Upper Cretaceous erosion-surface and then, possibly, covering even the higher elevations. The total thickness of the Nanaimo series was nearly 10,000 feet (3,000 m.) towards the close of its deposition, at which time it either extended far inland over the denuded crystalline rocks, covering the greater part of the range, or perhaps, it was re-

stricted to large basins. The series was uplifted, and in general deformed largely during post-Eocene times, into broad open folds with a northwest-southeast strike, corresponding with the trend of the island, and usually having an off-shore dip. In places the series has been closely folded, overturned, usually to the southwest, and broken by reversed and overthrust faults. Since its deformation, the Nanaimo series, being less resistant than the metamorphic and granitic rocks on which it lies, has been greatly eroded and reduced in area, and now forms lowlands, which are steeply surmounted by the metamorphic and granitic rocks.

The total area underlain by the Nanaimo series is about 1,800 square miles (4,700 km.^{2}). The principal basins are as follows: the Quatsino Sound basin, 49 square miles (127 km.^{2}), at the northern end of the island, extending to the west coast; the Suquash basin, 164 square miles (425 km.^{2}), on the east coast of the island separated from the Quatsino Sound basin by a narrow, low divide; and farther south on the east coast, bordering on the Strait of Georgia, the Comox basin 789 square miles (2,070 km.^{2}); the Nanaimo basin, 513 square miles (1,330 km.^{2}), and the Cowichan basin, 256 square miles (663 km.^{2}). In the central part of the island at the head of one of the long fiords which indent the west coast, is the Alberni basin, 66 square miles (171 km.^{2}). Besides those given above, there are several small outliers and basins of only a few square miles in extent. The area which is underlain by workable coal-seams is, however, much less than the total area underlain by the Coal Measures, being approximately one-third of the latter. Those basins which probably contain workable coal-seams are the Koskeemo, which is a portion of the Quatsino Sound basin, the Suquash basin, and portions of the Comox, Nanaimo, and Alberni basins. Of these the Suquash, Comox, and Nanaimo basins contain workable coal-seams, which are being mined at present.

At Suquash several seams of coal, at least two of which are workable, occur in a grey siliceous sandstone, with several thick interbeds of shale. The measures are regular and only slightly deformed. The general structure appears to be a broad syncline, striking about N. 60° E., and pitching slightly

to the northeast. The dips are low (less than 10 degrees), and although there are several local rolls there are no sharp ones. The measures are broken by a few normal faults of very small displacement, and in the southern part of the basin they have been intruded by a trachyte porphyry. The coal-seams are regular and do not pinch and swell as do those of the Nanaimo and Comox basins. They are, however, thin and contain a large number of persistent partings. The coal, an analysis of which is given below, is of the low-carbon bituminous class with a high water content grading towards a sub-bituminous or lignitic coal. The upper of the two known workable seams is now being mined in a small way with successful results.

In the Comox field, the coal occurs in several seams in a greyish-white sandstone, which directly overlies the metamorphic volcanics. Three of the seams have been mined. Since the surface on which the sandstone was deposited was very uneven, some of the higher irregularities remained above the depositional level during the formation of the lowest coal-seam, which occurs near the base of the sandstone. Hence, the lowest seam is frequently cut out by knobs of the metamorphic volcanics. The measures are rather regular and, in general, the structure is a simple monocline with a fairly uniform dip of about 10 degrees to the northeast. There are, however, small folds and a few faults, besides many small, sharp rolls, pinches, and swells in the coal-seams. Large "wants," due to silting during the deposition of the coal, are also common. In places a dacite porphyry has broken through the measures and forms a flow or intrusive sheet overlying them. Near the porphyry, the coal is broken and partially coked.

The Comox coal is coking, bituminous, and the highest in fixed carbon content of all the Vancouver Island coals. Extensive mining has been carried on since 1888 in the central part of the basin, near the town of Cumberland, and an earlier attempt at mining was made farther south from 1875 to 1877. The production to December 31, 1912, has been about 6,600,000 metric tons, and a considerable amount of coke has been made.

The Nanaimo coal-field is situated at the northwestern end of the Nanaimo basin and the productive area is only about

65 square miles (168 km.²), but the area virtually known to be underlain by workable coal-seams is somewhat larger. The coal occurs chiefly in the lower part of the Nanaimo series, in three seams, the Wellington, the Newcastle, and the Douglas, and is associated with conglomerates, sandstones, and shales. The measures are moderately disturbed and have a general monoclinal structure with a low dip to the northeast. There are a few rather large, open folds and many smaller ones. There are many minor faults, and in the southwestern part of the field two reversed strike-faults with relatively large throws are found. The coal-seams are remarkably persistent considering the great variability of the associated rocks, but vary greatly in thickness and quality. In places a variation as great as from 2 or 3 feet (0·6 or 0·9 m.) of dirty slickensided coal or "rash," to 30 feet (9 m.) of clean coal, occurs within a lateral distance of 100 feet (60 m.). It seems as if this extreme variation is due to a folding of dirty or silty coal-seams, when the clean coal, at least, was in a plastic or pasty condition, permitting it to flow away from the bends, where an increased vertical pressure was developed, to the limbs of the folds, where there was a corresponding decrease of pressure. There are also large, barren places in the seams due to silting or similar causes. The coal is a high-volatile, bituminous coal of a fair quality and cokes readily, especially the coal from the Wellington seam. The coal has been the source of a flourishing industry since 1860 and, up to December 31, 1912, the field had produced about 24,500,000 metric tons, approximately three-fifths of the total production of British Columbia. The present output is more than 1,000,000 tons a year, over one-third of the entire output of British Columbia.

Recent Analyses. Collector, C. H. Clapp. Analyst, F. G. Wait.

	Proximate Analysis.				Ultimate Analysis.					C. / H.	Calculated cal. value dry coal. calories
	Moisture	Vol.	F.C.	Ash	C.	H.	N.	O.	S.		
Wellington seam, Run of mine E. Wellington No. 1 mine.....	1·65	43·25	45·52	9·24	72·80	5·17	0·88	10·67	1·24	14·1	7·230
Wellington seam 1, 2, and 3 Extension mines....	1·16	40·47	50·04	7·80	75·53	5·13	1·19	9·82	0·53	14·7	7·450
Douglas seam. Run of mine S. Wellington mine.....	1·54	33·30	56·23	8·44	74·46	5·42	1·37	9·82	0·49	13·7	7·470
Upper Suquash seam Suquash mine.....	5·63	37·27	42·07	13·85	60·73	4·67	1·18	18·39	1·18	13·0	7·560

Summary of Investigation by the Department of Mines, Canada, on Regular Commercial Samples of Vancouver Island Coals.[1]

Analyses.

Source of Coal.	Moisture.		Proximate Analysis of Dry Coal.			Ultimate Analysis of Dry Coal.					Cal. value dry coal B.T.U.
	Mine	Air dried	Vol.	F.C.	Ash	C.	H.	N.	O.	S.	
Wellington seam Extension mine	1·8	1·1	40·1	49·8	10·1	72·9	4·7	1·2	10·7	0·4	13,160
Douglas seam Nanaimo No. 1 mine	2·2	1·6	41·2	48·5	10·3	72·1	4·8	1·2	10 7	0·9	12,830
Newcastle seam Nanaimo No. 1 mine	2·4	1·9	41·5	46·6	11·9	69·0	4·6	1·2	12·0	1·3	12,470
Comox seam Mines 4 and 7 Lower seam washed	1·0	.....	30·8	60·3	8·9	77·6	4·6	1·1	7·0	0·8	13,590
Suquash seam Alert bay	.....	7·0	34·3	42·7	23·0	.....	.....	.....	.....	1·0	11,100
" washed	.....	5·3	36·7	48·2	15·1	.....	.....	.....	.....	0·9	11,560

[1] From "An Investigation of the Coals of Canada," Mines Branch, Dept. of Mines, No. 83.

Boiler Tests.

Source of Coal.	Carlorific value of coal per lb. as fired. B.T.U.	Moisture in coal as fired. %	Ash and clinker for dry coal. %	Equivalent evaporation per lb. as fired.
Wellington seam, Extension colliery.....	12,980	1·4	6·3	6·76
Douglas seam, Nanaimo No. 1 mine.....	12,540	2·3	8·7	6·59
Newcastle seam, Nanaimo No. 1 mine.....	12,210	2·1	11·4	6·17
Comox seam, Comox colliery Nos. 4 and 7	12,880	1·0	10·8	7·41
" " washed.....	13,180	3·0	9·86	7·68
Suquash seam, Alert bay	10,950	5·3	15·86	5·92

Coking Tests.

Source of Coal.	Age of sample in months.	Type of oven.	Time of coking in hours.	Remarks.	Class of coke.
Wellington seam					
" Extension colliery.....	9	Otto-Hoffman	48	Medium good coke	−A
" " "	2½	Bernard	48	Fair coke	−A
" " "	2½	Beehive	74	Regular fracture, prisms of bright good looking coke	A
Douglas seam					
W. F. Co. No.1 mine.....	9	Otto-Hoffman	48	Lower part caked, not commercial	C
" " " "	9	Bernard	48	Poor commercial coke	
" " " "	2½	Bernard	48	Very friable	B
Newcastle seam					
W. F. Co. No. 1 mine.....	9	Otto-Hoffman	48	No real coke, non-coking coal	C
Comox seam					
" Colliery No. 4.....	8½	"	48	Poor coke, coal not fresh enough	−A
" " Nos. 4 and 7 mixed....	8½	"	48	Better than from No 4 mine	−A

A=Good commercial coke, − subdivided+A, A,−A.
B−Poor " " " + B, B,−B.
C=An agglomerate, not commercial coke,−subdivided+C, C,−C.

Gas Producer Tests.

Description.	Wellington coal seam, Upper seam No. 1 mine, Western Fuel Co. Ltd., Nanaimo, B.C.	Newcastle coal seam, Lower seam No. 1 mine, Western Fuel Co. Ltd., Nanaimo, B.C.
Volatile matter %	40·3	39·7
Ash	13·7	16·8
Moisture	1·5	2·0
Cal. value of coal as charged. B.T.U.	12640	12220
" " gas (lower) per cub. ft. B.T.U.	124·5	130·4
Producer efficiency	0·515	0·390
Coal per B.H.P. per hr. lbs.	1·88	2·52
Caking of coal	Slight	Trouble
Average interval between poking	53 mins.	1½ hrs.
Clinker	No difficulty	Very little trouble
Tar	48 lbs.	17 lbs. (very troublesome)
Uniformity in gas quality	Fair	Medium
Amount of steam used	Moderate	Moderate
Combustible in refuse	Moderate	High
Remarks	Needed attention but fire was not hard to work. Trouble with tar in engine valves	Required much attention, trouble from tar, which gas washer did not remove properly

Summary of Coal Resources of Vancouver Island.

GROUP I.

Including Seams of 1 Foot or Over, to a Depth of 4,000 Feet.

District.	Coal-Seams.		Actual Reserve (Calculation based on actual thickness and extent).			Probable Reserves (Approximate estimate).			Possible Reserve.
	No.	Thickness aggregate feet	Area in square miles	Class of coal†	Metric tons	Area in square miles	Class of coal†	Metric tons	Square miles
Nanaimo	3	10	77	B_2	1,060,000,000	181	B_2	1,339,000,000	513
Upper Nanaimo	1	3	.....			4	B_2	11,000,000	
Comox	3	10	79			339	B_2	3,383,000,000	789
Suquash	2	4	29	B_3	118,000,000	96	B_3	384,000,000	164
Alberni	1	3	.....	.....	.....	16	B_2	47,000,000	66
Quatsino sound (Koskeemo)	2	3	.....	.....	.....	9	B_2	27,000,000	49
Cowichan	....	.....	.....	.....	.....	.....	.....	.....	256
Minor basins of southern Vancouver island	....	.....	.....	.....	.....	.....	.....	.....	13
Minor basins of northern Vancouver island	....	.....	.....	.....	.....	.....	.....	.....	8
			185	.....	1,178,000,000	645	.....	5,191,000,000	1,858
Totals	....	.....	.....	.....	.....	.....	B_2	5,867,000,000	
							B_3	502,000,000	
								6,369,000,000	

† For classification of coal see Preface.

COAL-FIELDS OF QUEEN CHARLOTTE ISLANDS.

(*By C. H. Clapp.*)

The coals of Queen Charlotte islands are of Upper or Lower Cretaceous, and of Tertiary, probably Miocene age. The Cretaceous fuels range from semi-anthracite or high-carbon bituminous to low-carbon bituminous coal. The Tertiary coals are lignites, most of them brown with a woody or fibrous structure, although some are black, with an irregular coaly structure and conchoidal fracture.

The Cretaceous coals occur in a shaly sandstone formation, which is the lowest member of the Cretaceous series. As far as one can tell, all the coal-seams occur at about the same horizon, a few hundred feet below the top of the shaly sandstone series, and from a few hundred feet to a few thousand feet above the base of the series. The largest area of the Cretaceous series borders on and underlies Skidegate inlet, which separates the two largest islands of the Queen Charlotte group, Graham island to the north and Moresby island to the south, and extends northward on Graham island for some 20 miles. It was deposited in a wide valley, now occupied by the Honna and Yakoun rivers, between highlands composed of pre-Cretaceous meta-volcanics and intrusive rocks. In the valley there were apparently two or three large monadnocks, which remained above the depositional level during the formation of the coal-seams. The series has been intensely deformed and squeezed into tight folds between the old crystalline rock ridges. It has also been intruded and capped by volcanic rocks, presumably during or shortly following the deformation and before the extensive erosion which both the sedimentary and the intrusive rocks have suffered. As a result, there is one fairly large synclinal basin of the Coal Measures about 57 square miles (148 km.^{2}) in area in the southern part of Graham island and underlying Skidegate inlet, and there are several small synclinal basins in the vicinity of the old pre-Cretaceous highlands and monadnocks. Coal has been found near the western border of the large basin near Cowgitz and Camp Robertson. Three of the small, de-

tached basins are coal-bearing, the Camp Wilson basin being the best known. The coal is usually rather high in ash and in places is greatly crushed. Some of the semi-anthracites near Cowgitz are strangely high in water. A fairly extensive attempt at mining the semi-anthracite at Cowgitz was made in 1871, but the measures were so greatly deformed and the coal was so badly crushed that the enterprise was abandoned. During 1912 another attempt to mine the semi-anthracite north of Cowgitz was begun. It is as yet too soon to judge of the success of the enterprise. Renewed interest in the Queen Charlotte Islands coal-fields has led to the beginning of the first systematic prospecting during the last two years. The following are typical analyses of the Cretaceous coals:—

	1	2	3	4
Water	1·60%	6·85%	0·80%	2·44%
Volatile combustible	5·02	5·43	23·27	35·96
Fixed carbon	83·09	66·32	51·39	48·64
Ash	8·76	21·40	24·54	12·96
Sulphur	1·53	.....	.....	.....
	100·00	100·00	100·00	100·00
Coke	91·85%	87·72%	75·93%	61·60%
Character of coke	.....	(non-coherent)		(firm coherent)
Fuel ratio	16·5	12·21	2·21	1·35

1. Six-foot seam at Cowgitz, J. Richardson, collector; B. J. Harrington, analyst. Geological Survey of Canada, Report of Progress, 1872-73, p. 81.
2. "B" seam, tunnel of British Pacific Coal Company, north of Cowgitz. C. H. Clapp, collector; F. G. Wait, analyst.
3. Coal from Camp Robertson. W. A. Robertson, collector; G. C. Hoffmann, analyst. Geological Survey of Canada Report 92-93, Vol. VI, p. 12 R.
4. Coal from Camp Wilson. C. H. Clapp, collector; F. G. Wait, analyst.

The northeastern part of Graham island is low and largely covered by superficial deposits. The few widely-scattered outcrops are Tertiary sediments, chiefly sandstones, with some sandy shales and conglomerates, and Tertiary lavas, chiefly basalts and augite andesites. Lignite is known to occur in several localities, the best known of which is Skonun point on

the north shore. Here, at low tide, there are exposed more than ten seams, of varying persistency, of a tough woody lignite, which is curiously more resistant to wave erosion than the sandy shales with which it occurs. The seams range from 1 foot to 15 feet (0·3 to 1·8 m.) in thickness. The lignite-bearing measures have been considerably deformed, the structure being apparently a small anticline with a general east-west strike, broken along the crest by a strike fault. In other places, as at Tow hill to the east of Skonun point, the measures are overlain by the basaltic lavas. The following is an analysis of the woody lignite exposed at Skonun point, C. H. Clapp, collector; F. G. Wait, analyst.

Water	11·03%
Volatile combustible	49·75
Fixed carbon	35·94
Ash	3·28
	100·00
Coke	39·22%
Character of coke	Coherent but tender
Fuel ratio	0·72
Split volatile ratio	2·33

Summary of Coal Resources of Graham Island, Queen Charlotte Islands.

GROUP I.

Including Seams of 1 Foot or Over, to a Depth of 4,000 Feet.

District.	Coal-Seams.		Actual Reserve (Calculation based on actual thickness and extent).			Probable Reserves (Approximate estimate).			Possible Reserve.
	No.	Thickness aggregate feet	Area in square miles	Class of coal†	Metric tons	Area in square miles	Class of coal†	Metric tons	Square miles
Cretaceous Measures									
Skidegate	3	6	1·1	A_2	3,300,000	57	A_2, B_2	285,000,000	
Robertson camp	2	3	0·8	A_2, B_2	2,400,000				
Wilson camp	1	4	0·3	B_2	1,200,000	0·8	B_2	3,000,000	168
Threemile creek	1	3	.....	.....	.....	1·3	B_2	4,000,000	
Minor outlying areas	1	2	.....	.....	.....	0·5	A_2	1,000,000	2
North island	.....	.....	.....	.....	.....	.....	.....	.....	15
Numerous other areas of less than a square mile make up to several square miles.									
Totals	....	.....	2·2	.....	6,900,000	59·6	.....	293,000,000	185
Tertiary Measures									
Masset (Skonun Pt.)	10	30	2	D_2	60,000,000	57	D_2	555,000,000	
Naden harbour	....	3	.....	.....	.....	1·6	D_2	4,500,000	Prob-
East coast	....	6	.....	.....	.....	74	D_2	430,000,000	ably
Chinundunal brook	....	3	.....	.....	.....	1·3	D_2	3,500,000	very
Mamin river	....	3	.....	.....	.....	2·4	D_2	7,000,000	large
Totals	....	.....	2	.....	60,000,000	136	D_2	1,000,000,000	

† For classification of coal see Preface.

CHAPTER VIII.

YUKON.

(By D. D. Cairnes.)

INTRODUCTORY.

Yukon contains an area of about 196,978 square miles (510,561 square kilometres), and is thus considerably larger than Great Britain and Ireland, and almost as large as the German empire. A great portion of this extensive territory still remains practically unknown even to the prospector and miner; in fact almost all exploration has been restricted to areas within easy reach of the navigable waterways. A glance at the accompanying map (Figure 9) will show how extensive are the coal-bearing formations in the limited areas explored, and there is no reason to suppose that the mineral fuels will not be as correspondingly plentiful in the unprospected and unexplored portions of Yukon as in the better known and more accessible localities.

COAL-BEARING FORMATIONS.

The coal-bearing formations of Yukon are all of either Tertiary or Jura-Cretaceous age—the mineral fuels in the Tertiary beds throughout the territory being lignites, characterized in most places by the presence of considerable amounts of fossil resin or amber, while those of Jura-Cretaceous age range from high-grade lignite to anthracite.

Tertiary coal-bearing beds do not cover very extensive areas, but have a somewhat wide distribution and, in places, apparently constitute remnants of once larger areas now infolded with older terranes; in most cases, however, they represent deposits laid down in separate basins of deposition. The fossil plant remains found in these beds, show that most of them, at least, are of fresh-water origin. These lignite-bearing Tertiary beds appear to belong to the Kenai series, which is the

oldest known Tertiary in Yukon and Alaska and is generally referred to the upper Eocene. These rocks are, in most places, but little disturbed, although locally they have suffered considerable deformation. They consist, typically, of light-coloured, slightly coherent conglomerates and sandstones and dark to light-coloured, soft shales and clays. In places volcanic materials occur associated with these sediments.

The Jura-Cretaceous sediments consist mainly of conglomerates, quartzites, sandstones, greywackes, arkoses, tuffs, shales, and slates, having a wide range of colour and differing greatly in the amount of metamorphism they have suffered. In general, they are considerably more indurated, and the beds have been much more disturbed than those of Tertiary age. The Jura-Cretaceous beds appear to be remnants of former extensive areas which were originally all connected but have been reduced by erosion to their present proportion. In southern Yukon, where these beds have been studied, the uppermost member, the Tantalus conglomerate, is composed dominantly of cherty conglomerate beds which have an aggregate thickness of at least 1,000 feet (300 m.). The underlying Laberge series has an average thickness of about 3,800 feet.

In the Jura-Cretaceous beds, two distinct coal horizons have been recognized. The upper horizon occurs well up in the Tantalus conglomerates, and the lower horizon is in the Laberge rocks, within a zone 200 to 300 feet (60 to 90 m.) below the Tantalus conglomerates.

The beds found to be coal-bearing in Yukon occur in at least eighteen distinct areas. In thirteen of these, coal of economic importance has been discovered, and may yet be found in the remaining five.

The following table gives the extent of these rocks:—

Extent of known Tertiary beds in Yukon.....	2,090 sq.miles	(5,410 sq.km.)
Extent of known Jura-Cretaceous beds in Yukon	4,110 "	(10,650 ")
Totals.....	6,200 sq.miles	(16,060 sq.km.)
Probable extent of Tertiary beds in Yukon.....	4,500 sq.miles	(11,600 sq.km.)
Probable extent of Jura-Cretaceous beds in Yukon.....	19,700 "	(50,000 ")
Totals.....	24,200 sq.miles	(61,600 sq.km.)

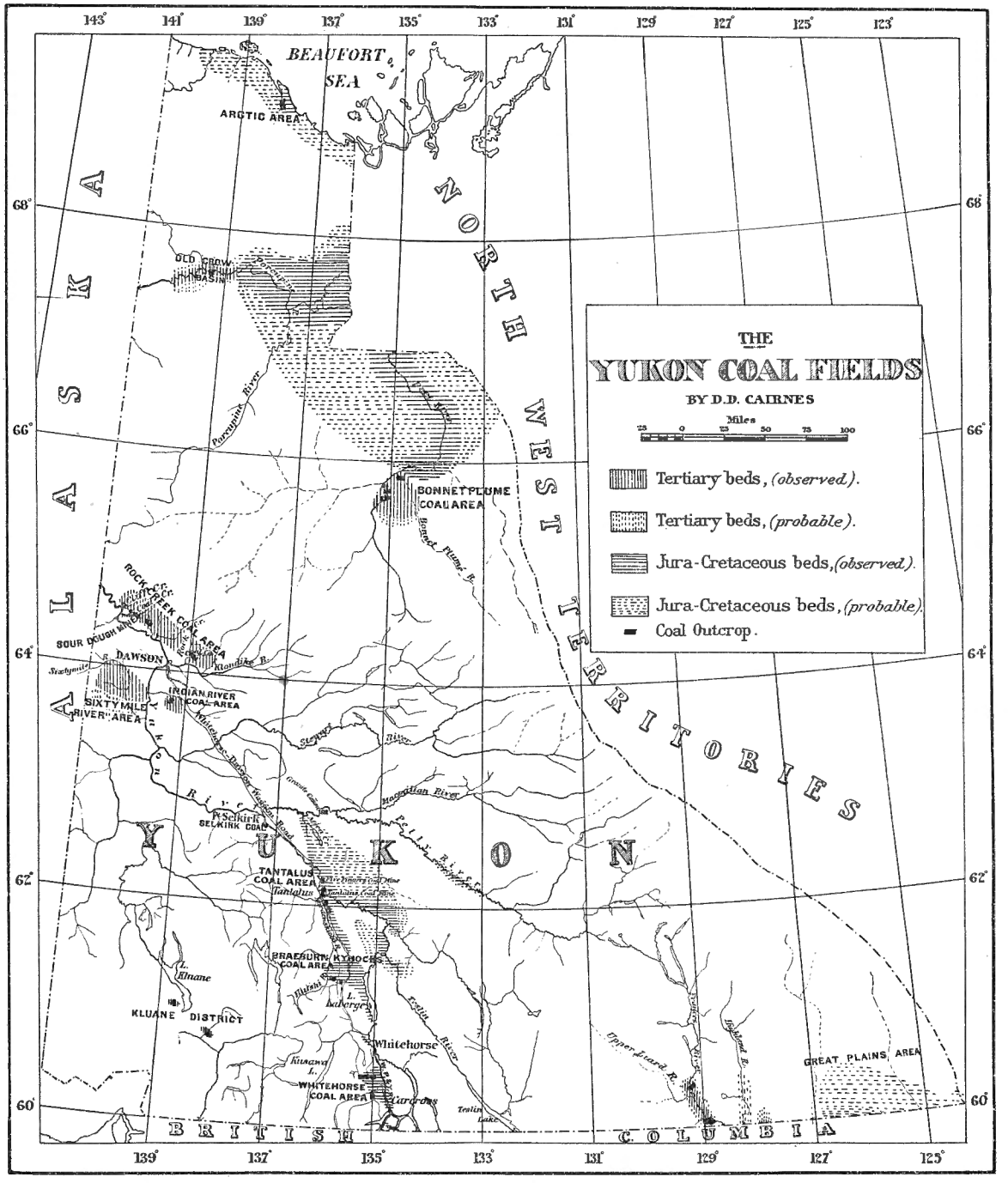

Figure 9. Yukon coal-fields.

CHARACTER OF THE COAL.

At only five points in Yukon has coal actually been mined, viz., on Cliff creek, on Coal creek (tributary of Yukon river), on Coal creek (tributary of Rock creek), at Five Fingers mine, and at Tantalus mine. The first three of these occur in the Rock Creek Tertiary basin, and the last two are situated within the Tantalus Jura-Cretaceous area. At two or three other points the measures have been prospected. The only two mines that have been in operation since 1908 are the Sour Dough mine on Coal creek (tributary of the Yukon) and the Tantalus mine situated on Lewes river about midway between Whitehorse and Dawson.

The following table gives the analyses of a number of typical coals from different parts of the territory:—

Locality.	Age.	Hygroscopic water.	Volatile combustible matter.	Fixed carbon.	Ash.
Cliff creek	Tertiary	8·57%	42·04%	45·77%	3·62%
		10·58	40·10	46·74	2·58
Sour Dough mine	Tertiary	17·10	34·50	38·40	10·00
		14·57	33·11	37·15	15·17
Coal creek, tributary of Rock creek		18·31	34·96	40·88	5·85
		19·37	33·85	37·54	9·33
Five Fingers mine	Jura-Cretaceous	5·95	40·46	45·16	8·43
Tantalus butte	Jura-Cretaceous	13·64	31·83	51·84	2·69
		12·87	31·72	49·51	5·90
Braeburn-Kynocks area	Jura-Cretaceous	8·98	29·62	48·30	13·10
		12·02	34·28	42·56	11·14
Whitehorse area	Jura-Cretaceous	2·15	6·01	69·86	21·98
		3·76	8·34	65·50	25·40

Average samples of 500 pounds (226 kilograms) each from the three seams being worked at the Tantalus mine have been analysed with the following results:—

	Upper Seam Average thickness 3 feet (0·9 m.)	Middle Seam Average thickness 6 feet 6 inches (1·97 m.)	Lower Seam Average thickness 7 feet 6 inches (2·28 m.)
	Raw	Raw	Raw
Moisture in sample as received in laboratory	0·9%	0·7%	0·7%
Proximate analysis of coal, dried at 105°C.—			
Fixed carbon	58·0	54·1	56·0
Volatile matter	25·0	26·7	27·8
Ash	17·0	19·2	16·2
Ultimate analysis of dried coal			
Carbon	69·8	....	71·1
Hydrogen	4·0	....	4·3
Sulphur	0·5	0·5	0·5
Nitrogen	0·8	0·9	0·7
Oxygen	7·9	....	7·2
Ash	17·0	....	16·2
Calorific value of dried coal by determination	Calories 6,700	6,310	6,790
Calorific value of dried coal by determination	B.T.U. 12,060	11,360	12,230

Coking tests of these coals, made for the Mines Branch of the Department of Mines, showed that only the coal of the lower seam produced a coke of commercial value.

Summarized, the results of the tests were:—

	Yield.	Quality.
Upper seam, raw.....	75·9%	Not a commercial coke; grey in colour, dense but crumbling, and without regular fracture.
" " washed...	75·3	A poor commercial coke; similar to that from the raw coal, though sounder.
Middle seam, raw.....	75·8	Not a commercial coke; similar to the product from the raw coal of the upper seam.
" " washed...	77·4	Possibly a commercial coke; not as good as that from the washed coal of the upper seam.
Lower seam, raw.....	74·6	A very fair commercial coke; probably suitable for blast furnace fuel.
" " washed...	74·1	A commercial coke; harder and sounder than that from the raw coal.

The following table gives the probable amount of coal in Yukon in seams 1 foot (0·30 m.) or over in thickness:—

SUMMARY OF COAL RESOURCES OF YUKON.

FIELD	Area square miles	Class of coal†	Age	Metric tons
Whitehorse area	300	A_2	Jura-Cretaceous	40,000,000
Tantalus area	690	B_2	Jura-Cretaceous	70,000,000
		B_3	Jura-Cretaceous	80,000,000
Braeburn-Kynocks area	310	B_3	Jura-Cretaceous	50,000,000
Selkirk area	100	B_3	Jura-Cretaceous	10,000,000
Belly River areas		B_3	Jura-Cretaceous	
Arctic area		B_3 to D_1 (?)		
Rock Creek area	600	D_1	Tertiary	3,000,000,000
Kluane district	20	D_1	Tertiary	40,000,000
Bonnet Plume area	400	D_2	Tertiary	1,500,000,000
Indian River area	150	D_2	Tertiary	150,000,000
Old Crow basin	120	D_2	Tertiary	
Francis and Liard River basins	150	D_2	Tertiary	
Totals	2,840			4,940,000,000

† For classification of coal see Preface.

The coal production in Yukon has been small, partly because there has been little demand for coal, up to the present, and partly because only a few of the deposits are conveniently situated for shipping purposes. The production for the past three years in metric tons was, approximately:—

1910	1911	1912
11,800	12,200	8,600

CHAPTER IX.

NORTH WEST TERRITORIES AND ARCTIC ISLANDS.

NORTH WEST TERRITORIES.

FORT NORMAN, MACKENZIE RIVER.

In a Tertiary area on the Mackenzie river, coal was observed by Sir Alexander Mackenzie in 1789 and since that time various explorers have found coal-seams. The section given by McConnell includes seams of 4 feet and 3 feet. One seam, which was concealed at the time of his visit, was reported by Sir John Richardson to be 9 feet thick. The basin containing deposits of Tertiary age extends a short distance up Great Bear river. The edge of the basin to the west is defined by a range of limestone mountains running parallel to the river at a distance of about 20 miles. The area is thus less than 40 miles in length by 30 miles in width, or under 1,200 square miles. The part underlain by the three seams above mentioned is probably less than one-quarter of the above, or 300 square miles, which with 16 feet of coal would give a maximum coal reserve of 4,800,000,000 tons.

MACKENZIE DELTA.

Cretaceous shales and sandstones are found on both banks of the river and in the valley of Peel river to the west. The hills on the Peel River portage and Rat river are sandstones and shales containing Cretaceous fossils. There are few exposures of coal, and the seams are of insignificant dimensions. From the Mackenzie east to Cape Parry, Cretaceous or Tertiary deposits were found by Sir John Richardson. At Point Trail these "alum shales" had been on fire. "The burnt clays, variously coloured, yellow, white, and deep red, give it much the appearance of the rubbish of a brick field." The explorations of V. Stefansson, 1910-1911, confirm the coal-bearing character of these beds. One section on Horton river, southwest of Franklin bay, shows exposures of sands and clays with coal seams, extending along the river banks for 8 miles. At one point 10 feet of coal occurs in several small seams, the largest being 4 feet in thickness.

Summary of Coal Resources of North West Territories.

GROUP I.

Including Seams of 1 Foot or Over, to a Depth of 4,000 Feet.

District.	Coal-Seams.		Probable Reserves (Approximate estimate).		
	No.	Thickness	Area	Class of coal	Metric tons
Fort Norman	3	4 feet, 3 feet, and 9 feet	300 square miles	Lignite	4,800,000,000
Peel river	....	.....	.....	.....	Partially explored
Horton river	....	.....	.....	.....	Partially explored

ARCTIC ISLANDS.

Coal has been found in two series of beds on the Arctic islands, the older underlying the Carboniferous limestone and the younger being probably of Tertiary age.

CARBONIFEROUS.

The rocks of the Parry islands dip generally to the north, so that the outcrops cross the group in a general east and west direction. Professor Haughton, in an appendix to McClintock's "Narrative of the Discovery of the fate of Sir John Franklin," London, 1859, writes of the age of these beds as follows:—

"The Upper Silurian limestones, already described, are succeeded by a most remarkable series of close-grained beds of highly bituminous coal, and but few marine fossils, in fact, the only fossil shell found in these beds, so far as I know, in any part of the Arctic archipelago, is a species of ribbed *Atrypa* which I believe to be identical with the *Atrypa fallax* of the Carboniferous slate of Ireland. These sandstone beds are succeeded by a series of blue limestone beds, containing an abundance of the marine shells commonly found in all parts of the world where the Carboniferous deposits are at all developed."

The age of the coal-bearing formation does not correspond with that of the Carboniferous Coal Measures of lower latitudes, and is probably not far above the divisional line between the Devonian and Carboniferous. In the many sledge journeys made during the Franklin search, loose pieces of coal were found at a great number of places on the islands, although few exposures of coal-seams are recorded. This is quite natural under the conditions of travel in the north. The later expeditions by the Canadian Government were equally unsuccessful, but it is brought out by analyses of specimens that three classes of fuel occur there: coal, cannel-coal, and oil-shale.

One discovery of a coal-seam in place on the north coast of Banks island is reported by Captain Bernier. This appears to be in the cliffs at a height of about 400 feet above sea-level

near Rood head, 9 miles east of Cape Hamilton. The geologist in charge, Mr. McMillan, described it as a lens-shaped deposit exposed for a mile in length, being perhaps 50 feet thick in the centre and averaging 10 feet for half its length.

A coal-seam is also recorded in the vicinity of Bay of Mercy, Banks island.

The character of the coal picked up on the south shore of Melville island is shown in the following analysis:—

Moisture	1·52%
Volatile matter	44·88
Fixed carbon	24·43
Ash	29·17
	100·00

Three other samples from unrecorded localities show varying characters as follows:—

	(31)	(40)	(41)
Moisture	3·83%	0·97%	1·42%
Volatile matter	36·11	40·13	46·60
Fixed carbon	46·78	16·17	33·13
Ash	13·28	42·19	18·85
	100·00	100·00	100·00

This coal-bearing formation is supposed to thin out to the east, as it is not present on Elsmere island.

TERTIARY.

A few small areas of rocks, supposed to be of Tertiary age, are mapped on the western islands. These contain partly carbonized wood. Larger areas are found on Baffin island (northern part) and Bylot island. These newer discoveries have not been fully described, but it is known that deposits similar to those of Greenland have been found. Northward

on Elsmere island, the Tertiary coal-bearing formation is largely developed in the vicinity of Lady Franklin sound. At Cape Murchison, Sir George Nares reports a seam of coal 25 feet thick. This may be made up of two seams as the complete section was not exposed. Coal has been found at Lincoln bay to the north, and also on Archer fiord to the south, near Lady Franklin sound. Inland, Captain Greely reports coal at Hazen lake.

Dr. Moss, of H.M.S. *Alert*, collected specimens of coal at Cape Murchison. These were analysed with the following results[1]:—

Carbon	75·49%
Hydrogen	5·60
Oxygen and nitrogen	9·89
Sulphur	0·52
Ash	6·49
Moisture	2·01

[1] *Journal Royal Society, Dublin*, Vol. I, 1877-78, page 61.

SUMMARY OF COAL RESOURCES OF ARCTIC ISLANDS.

DISTRICT.	COAL-SEAMS.		PROBABLE RESERVES (Approximate estimate).			POSSIBLE RESERVE.
	No.	Thickness	Area in square miles	Class of coal†	Metric tons	
Banks island	1	lens 0-50 feet	6,000	B_2, C	6,000,000,000	
Parry islands	.....	.....				
Elsmere island	1	10 feet	.....	.....	.....	Small
Baffin island	.....	.....	.....	.....	.....	Moderate
Bylot island	.....	.....	.....	.....	.....	Small
Total	.....	.....	.....	.....	6,000,000,000	

† For classification of coal see Preface.

INDEX.

A.

B.

C.

D.

E.

F.

G.

H.

I.

J.

K.

L.

M.

N.

O.

P.

Q.

R.

S.

T.

U.

V.

W.

Y.

Z.

LIST OF RECENT REPORTS OF GEOLOGICAL SURVEY.

Since 1910, reports issued by the Geological Survey have been called memoirs and have been numbered Memoir 1, Memoir 2, etc. Owing to delays incidental to the publishing of reports and their accompanying maps, not all of the reports have been called memoirs, and the memoirs have not been issued in the order of their assigned numbers and, therefore, the following list has been prepared to prevent any misconceptions arising on this account. The titles of all other important publications of the Geological Survey are incorporated in this list.

Memoirs and Reports Published During 1910.

REPORTS.

Report on a geological reconnaissance of the region traversed by the National Transcontinental railway between Lake Nipigon and Clay lake, Ont.—by W. H. Collins. No. 1059.

Report on the geological position and characteristics of the oil-shale deposits of Canada—by R. W. Ells. No. 1107.

A reconnaissance across the Mackenzie mountains on the Pelly, Ross, and Gravel rivers, Yukon and North West Territories—by Joseph Keele. No. 1097.

Summary Report for the calendar year 1909. No. 1120.

MEMOIRS—GEOLOGICAL SERIES.

MEMOIR 1. *No. 1, Geological Series.* Geology of the Nipigon basin, Ontario —by Alfred W. G. Wilson.

MEMOIR 2. *No. 2, Geological Series.* Geology and ore deposits of Hedley mining district, British Columbia—by Charles Camsell.

MEMOIR 3. *No. 3, Geological Series.* Palæoniscid fishes from the Albert shales of New Brunswick—by Lawrence M. Lambe.

MEMOIR 5. *No. 4, Geological Series.* Preliminary memoir on the Lewes and Nordenskiöld Rivers coal district, Yukon Territory—by D. D. Cairnes.

MEMOIR 6. *No. 5, Geological Series.* Geology of the Haliburton and Bancroft areas, Province of Ontario—by Frank D. Adams and Alfred E. Barlow.

MEMOIR 7. *No. 6, Geological Series.* Geology of St. Bruno mountain, Province of Quebec—by John A. Dresser.

MEMOIRS—TOPOGRAPHICAL SERIES.

MEMOIR 11. *No. 1, Topographical Series.* Triangulation and spirit levelling of Vancouver island, B.C., 1909—by R. H. Chapman.

Memoirs and Reports Published During 1911.

REPORTS.

Report on a traverse through the southern part of the North West Territories, from Lac Seul to Cat lake, in 1902—by Alfred W. G. Wilson. No. 1006.

Report on a part of the North West Territories drained by the Winisk and Upper Attawapiskat rivers—by W. McInnes. No. 1080.

Report on the geology of an area adjoining the east side of Lake Timiskaming—by Morley E. Wilson. No. 1064.

Summary Report for the calendar year 1910. No. 1170.

MEMOIRS—GEOLOGICAL SERIES.

MEMOIR 4. *No. 7, Geological Series.* Geological reconnaissance along the line of the National Transcontinental railway in western Quebec—by W. J. Wilson.

MEMOIR 8. *No. 8, Geological Series.* The Edmonton coal field, Alberta—by D. B. Dowling.

MEMOIR 9. *No. 9, Geological Series.* Bighorn coal basin, Alberta—by G. S. Malloch.

MEMOIR 10. *No. 10, Geological Series.* An instrumental survey of the shore-lines of the extinct lakes Algonquin and Nipissing in southwestern Ontario—by J. W. Goldthwait.

MEMOIR 12. *No. 11, Geological Series.* Insects from the Tertiary lake deposits of the southern interior of British Columbia, collected by Mr. Lawrence M. Lambe, in 1906—by Anton Handlirsch.

MEMOIR 15. *No. 12, Geological Series.* On a Trenton Echinoderm fauna at Kirkfield, Ontario—by Frank Springer.

MEMOIR 16. *No. 13, Geological Series.* The clay and shale deposits of Nova Scotia and portions of New Brunswick—by Heinrich Ries, assisted by Joseph Keele.

MEMOIRS—BIOLOGICAL SERIES.

MEMOIR 14. *No. 1, Biological Series.* New species of shells collected by Mr. John Macoun at Barkley sound, Vancouver island, British Columbia—by William H. Dall and Paul Bartsch.

Memoirs and Reports Published During 1912.

REPORTS.

Summary Report for the calendar year 1911. No. 1218.

MEMOIRS—GEOLOGICAL SERIES.

MEMOIR 13. *No. 14, Geological Series.* Southern Vancouver island—by Charles H. Clapp.

MEMOIR 21. *No. 15, Geological Series.* The geology and ore deposits of Phoenix, Boundary district, British Columbia—by O. E. LeRoy.

MEMOIR 24. *No. 16, Geological Series.* Preliminary report on the clay and shale deposits of the western provinces—by Heinrich Ries and Joseph Keele.

MEMOIR 27. *No. 17, Geological Series.* Report of the Commission appointed to investigate Turtle mountain, Frank, Alberta, 1911.

MEMOIR 28. *No. 18, Geological Series.* The geology of Steeprock lake, Ontario—by Andrew C. Lawson. Notes on fossils from limestone of Steeprock lake, Ontario—by Charles D. Walcott.

Memoirs and Reports Published During 1913.

REPORTS, ETC.

Museum Bulletin No. 1: contains articles Nos. 1 to 12 of the Geological Series of Museum Bulletins, articles Nos. 1 to 3 of the Biological Series of Museum Bulletins, and article No. 1 of the Anthropological Series of Museum Bulletins.

Guide Book No. 1. Excursions in eastern Quebec and the Maritime Provinces, parts 1 and 2.

Guide Book No. 2. Excursions in the Eastern Townships of Quebec and the eastern part of Ontario.

Guide Book No. 3. Excursions in the neighbourhood of Montreal and Ottawa.

Guide Book No. 4. Excursions in southwestern Ontario.

Guide Book No. 5. Excursions in the western peninsula of Ontario and Manitoulin island.

Guide Book No. 8. Toronto to Victoria and return *via* Canadian Pacific and Canadian Northern railways: parts 1, 2, and 3.

Guide Book No. 9. Toronto to Victoria and return *via* Canadian Pacific, Grand Trunk Pacific, and National Transcontinental railways.

Guide Book No. 10. Excursions in Northern British Columbia and Yukon Territory and along the north Pacific coast.

MEMOIRS—GEOLOGICAL SERIES

MEMOIR 17. *No. 28, Geological Series.* Geology and economic resources of the Larder Lake district, Ont., and adjoining portions of Pontiac county, Que.—by Morley E. Wilson.

MEMOIR 18. *No. 19, Geological Series.* Bathurst district, New Brunswick—by G. A. Young.

MEMOIR 26. *No. 34, Geological Series.* Geology and mineral deposits of the Tulameen district, B.C.—by C. Camsell.

MEMOIR 29. *No. 32, Geological Series.* Oil and gas prospects of the northwest provinces of Canada—by W. Malcolm.

MEMOIR 31. *No. 20, Geological Series.* Wheaton district, Yukon Territory—by D. D. Cairnes.

MEMOIR 33. *No. 30, Geological Series.* The geology of Gowganda Mining Division—by W. H. Collins.

MEMOIR 35. *No. 29, Geological Series.* Reconnaissance along the National Transcontinental railway in southern Quebec—by John A. Dresser.

MEMOIR 37. *No. 22, Geological Series.* Portions of Atlin district, B. C.—by D. D. Cairnes.

MEMOIR 38. *No. 31, Geological Series.* Geology of the North American Cordillera at the forty-ninth parallel, Parts I and II—by Reginald Aldworth Daly.

Memoirs and Reports Published During 1914.

REPORTS, ETC.

Summary Report for the calendar year 1912. No. 1305.

Museum Bulletins Nos. 2, 3, 4, 5, 7, and 8 contain articles Nos. 13 to 22 of the Geological Series of Museum Bulletins, article No. 2 of the Anthropological Series, and article No. 4 of the Biological Series of Museum Bulletins.

Prospector's Handbook No. 1: Notes on radium-bearing minerals—by Wyatt Malcolm.

MUSEUM GUIDE BOOKS.

The archæological collection from the southern interior of British Columbia—by Harlan I. Smith. No. 1290.

MEMOIRS—GEOLOGICAL SERIES.

MEMOIR 23. *No. 23, Geological Series.* Geology of the coast and islands between the Strait of Georgia and Queen Charlotte sound, B.C.—by J. Austen Bancroft.

MEMOIR 25. *No. 21, Geological Series.* Report on the clay and shale deposits of the western provinces (Part III)—by Heinrich Ries and Joseph Keele.

MEMOIR 30. *No. 40, Geological Series.* The basins of Nelson and Churchill rivers—by William McInnes.

MEMOIR 20. *No. 41, Geological Series.* Gold fields of Nova Scotia—by W. Malcolm.

MEMOIR 36. *No. 33, Geological Series.* Geology of the Victoria and Saanich map-areas, Vancouver island, B.C.—by C. H. Clapp.

MEMOIR 52. *No. 42, Geological Series.* Geological notes to accompany map of Sheep River gas and oil field, Alberta—by D. B. Dowling.

MEMOIR 43. *No. 36, Geological Series.* St. Hilaire (Beloeil) and Rougemont mountains, Quebec—by J. J. O'Neill.

MEMOIR 44. *No. 37, Geological Series.* Clay and shale deposits of New Brunswick—by J. Keele.

MEMOIR 22. *No. 27, Geological Series.* Preliminary report on the serpentines and associated rocks, in southern Quebec—by J. A. Dresser.

MEMOIR 32. *No. 25, Geological Series.* Portions of Portland Canal and Skeena Mining divisions, Skeena district, B.C.—by R. G McConnell.

MEMOIR 47. *No. 39, Geological Series.* Clay and shale deposits of the western provinces, Part III—by Heinrich Ries.

MEMOIR 40. *No. 24, Geological Series.* The Archæan geology of Rainy lake —by Andrew C. Lawson.

MEMOIR 19. *No. 26, Geological Series.* Geology of Mother Lode and Sunset mines, Boundary district, B.C.—by O. E. LeRoy.

MEMOIR 39. *No. 35, Geological Series.* Kewagama Lake map-area, Quebec —by M. E. Wilson.

MEMOIR 51. *No. 43, Geological Series.* Geology of the Nanaimo map-area—by C. H. Clapp.

MEMOIR 61. *No. 45, Geological Series.* Moose Mountain district, southern Alberta (second edition)—by D. D. Cairnes.

MEMOIR 41. *No. 38, Geological Series.* The "Fern Ledges" Carboniferous flora of St. John, New Brunswick—by Marie C. Stopes.

MEMOIR 53. *No. 44, Geological Series.* Coal fields of Manitoba, Saskatchewan, Alberta, and eastern British Columbia (revised edition) —by D. B. Dowling.

MEMOIR 55. *No. 46, Geological Series.* Geology of Field map-area, Alberta and British Columbia—by John A. Allan.

MEMOIRS—ANTHROPOLOGICAL SERIES.

MEMOIR 48. *No. 2, Anthropological Series.* Some myths and tales of the Ojibwa of southeastern Ontario—collected by Paul Radin.

MEMOIR 45. *No. 3, Anthropological Series.* The inviting-in feast of the Alaska Eskimo—by E. W. Hawkes.

MEMOIR 49. *No. 4, Anthropological Series.* Malecite tales—by W. H. Mechling.

MEMOIR 42. *No. 1, Anthropological Series.* The double curve motive in northeastern Algonkian art—by Frank G. Speck.

MEMOIRS—BIOLOGICAL SERIES.

MEMOIR 54. *No. 2, Biological Series.* Annotated list of flowering plants and ferns of Point Pelee, Ont., and neighbouring districts—by C. K. Dodge.

Memoirs and Reports Published During 1915.

MEMOIRS—GEOLOGICAL.

MEMOIR 58. *No. 48, Geological Series.* Texada island—by R. G. McConnell.
MEMOIR 60. *No. 47, Geological Series.* Arisaig-Antigonish district—by M. Y. Williams.

Memoirs and Reports in Press, January 20, 1915.

MEMOIR 50. *No. 51, Geological Series.* Upper White River district, Yukon —by D. D. Cairnes.
MEMOIR 56. *No. 56, Geological Series.* Geology of Franklin Mining camp, B.C.—by Chas. W. Drysdale.
MEMOIR 62. *No. 5, Anthropological Series.* Abnormal types of speech in Nootka—by E. Sapir.
MEMOIR 63. *No. 6, Anthropological Series.* Noun reduplication in Comox, a Salish language of Vancouver island—by E. Sapir.
MEMOIR 46. *No. 7, Anthropological Series.* Classification of Iroquoian radicals with subjective pronominal prefixes — by C. M. Barbeau.
MEMOIR 59. *No. 55, Geological Series.* Coal fields and coal resources of Canada—by D. B. Dowling.
MEMOIR 67. *No. 49, Geological Series.* The Yukon-Alaska Boundary between Porcupine and Yukon rivers—by D. D. Cairnes.
MEMOIR 57. *No. 50, Geological Series.* Corundum, its occurrence, distribution, exploitation, and uses—by A. E. Barlow.
MEMOIR 64. *No. 52, Geological Series.* Preliminary report on the clay and shale deposits of the province of Quebec—by J. Keele.
MEMOIR 65. *No. 53, Geological Series.* Clay and shale deposits of the western provinces, Part IV—by H. Ries.
MEMOIR 66. *No. 54, Geological Series.* Clay and shale deposits of the western provinces, Part V—by J. Keele.
MEMOIR 70. *No. 8, Anthropological Series.* Family hunting territories and social life of the various Algonkian bands of the Ottawa valley—by F. G. Speck.
MEMOIR 71. *No. 9, Anthropological Series.* Myths and folk-lore of the Timiskaming Algonquin and Timagami Ojibwa—by F. G. Speck.
MEMOIR 69. No. *57, Geological Series.* Coal fields of British Columbia—by D. B. Dowling.
MEMOIR 34. *No. , Geological Series.* The Devonian of southwestern Ontario and a chapter on the Monroe formation—by C. R. Stauffer.
MEMOIR 73. *No. , Geological Series.* The Pleistocene and Recent deposits of the Island of Montreal—by J. Stansfield.

Summary Report for the calendar year 1913.