No estimate of the future of any operations within these areas, however, can be deduced from the above figures as these relate to the area as a whole rather than to any particular properties or section of the area.

This observation has particular relevance to the operations presently being conducted in the Red Deer Valley of the Drumheller area, commonly referred to as the Drumheller coal field. The estimate figures for this area, which are based on seams having a minimum thickness of 3 feet lying beneath a maximum depth of cover of 1,000 feet, indicate a substantial tonnage of probable mineable coal. On the other hand, the Commission has received engineering advice to the effect that the Drumheller coal field has now reached its maximum capacity and that, with few exceptions, the life of the mines at the present level of annual production is limited to twenty to thirty years. The essential feature of this local situation is the "bad land" topography of this section of the Red Deer Valley. The Edmonton formation in this area has a thickness of 1,050 feet and contains five workable seams which, in ascending order, are Nos. 1, 2, 5, 7 and 11. Most of the operations in the area are confined to seams Nos. 1 and 2. Seam No. 1 ranges in thickness from 3.3 feet to 7 feet and averages 5 feet. The seam lies about 130 feet above the base of the formation. Seam No. 2 ranges in thickness from 3 feet to 6.5 feet and averages 4.5 feet. It lies 30 feet above No. 1 seam. Red Deer Valley has a depth ranging from 300 to 500 feet in a width of 3 miles, beyond which limits the topography rises to considerably higher elevations. It is evident, therefore, that where No. 1 seam outcrops at valley level, the maximum depth of mining, which engineering advice has set at about 600 feet, will be reached when mining operations have proceeded about 1.5 miles from the point of entry. Where the Red Deer has cut its channel below the seam outcrop, the cover is generally correspondingly less, thus permitting more extended workings. On the assumption that 600 feet constitutes a maximum cover and that seams Nos. 5, 7 and 11 are not commercial in the Red Deer Valley, it would seem that the reserve situation in respect to many of the mines is assuming primary importance. It is possible that the operators in this area will find it feasible to continue operations beyond the point at which 600 feet of cover is reached. Failing that, the alternative will be for them to open up new operations in the adjacent uplands or in other areas. This may involve higher operational costs and the loss of convenient railway facilities.

SUMMARY

It is clear from the foregoing that Alberta has very extensive reserves of bituminous and sub-bituminous coals. The most valuable reserves from the point of view of both quality and quantity are concentrated in the Foothills belts, notably in the Inner Foothills belt. Of the Plains regions, the Edmonton formation is the more important and represents an extensive reserve of sub-bituminous coal. Markets, rather than reserves, are the fundamental problem of the Alberta coal mining industry.

PROVINCE OF BRITISH COLUMBIA

Coal deposits occur in widely distributed areas throughout the Province of British Columbia. Reference to Map 10 also shows that the deposits are generally confined to small areas. The majority of them, it will be noted, occur at great distances from the main population and industrial centres, important deposits in the northern part of the Province being without railway facilities.

COALFIELDS AND COAL AREAS OF BRITISH COLUMBIA
Prepared by B. R. MacKay, Geological Survey, 1946.
SCALE OF MILES
100 0 100
Local occurrence
Defined boundary
Undefined boundary
TERTIARY COAL AREAS
SOUTHERN BRITISH COLUMBIA
1 PRINCETON COAL AREA
2 TULAMEEN COAL AREA
3 MERRITT-NICOLA COAL AREA
4 QUILCHENA COAL AREA
5 WHITE LAKE COAL AREA
6 HAT CREEK COAL AREAS
7 KAMLOOPS COAL AREAS
8 NORTH THOMPSON RIVER (CHU CHUA) COAL AREA
9 FRASER RIVER DELTA COAL AREA
CENTRAL BRITISH COLUMBIA
10 BOWRON RIVER COAL AREA
11 FORT GEORGE COAL AREA
12 FRASER LAKE COAL AREA
13 NECHAKO RIVER COAL AREA
14 BLACKWATER COAL AREA
15 QUESNEL COAL AREA
16 COTTONWOOD COAL AREA
17 ALEXANDRIA COAL AREA
18 DRIFTWOOD CREEK COAL AREA
COAST RANGE DISTRICT
19 BELLA COOLA RIVER COAL AREA
20 KOHASGANKO (DEAN RIVER) COAL AREA
NORTHERN BRITISH COLUMBIA (Liard River Drainage Basin)
21 COAL RIVER COAL AREA
22 HYLAND RIVER COAL AREA
23 DEASE RIVER COAL AREA
24 RAPID RIVER COAL AREA
GRAHAM ISLAND
25 SKONUM POINT COAL AREA
UPPER CRETACEOUS COAL AREAS
VANCOUVER ISLAND
26 SUQUASH COAL AREAS
27 COMOX COAL AREA
a CUMBERLAND COAL AREA
b TSABLE RIVER COAL AREA
c CAMPBELL RIVER COAL AREA
28 NANAIMO COAL AREAS
29 COWICHAN COAL AREA
30 ALBERNI COAL AREA
GRAHAM ISLAND
31 COWGITZ AND OTHER COAL AREAS
LOWER CRETACEOUS COAL AREAS
SOUTHEASTERN BRITISH COLUMBIA COAL DISTRICT
32 CROWSNEST COAL AREAS
a FERNIE BASIN COAL AREA
b CORBIN BASIN COAL AREA
c TENT AND TAYLOR MOUNTAIN COAL AREA
33 FLATHEAD RIVER COAL AREAS
34 UPPER ELK RIVER COAL AREA
NORTHEASTERN BRITISH COLUMBIA COAL DISTRICT
35 PEACE RIVER CANYON COAL AREA
36 BUTLER RIDGE COAL AREAS
37 CARBON RIVER COAL AREA
38 FALLS CREEK COAL AREA
39 HASLER CREEK COAL AREA
40 HALFWAY-SIKANNI CHIEF RIVERS COAL AREAS
41 MINAKER RIVER COAL AREA
CENTRAL BRITISH COLUMBIA COAL DISTRICT (Skeena River Drainage Basin)
42 TELKWA RIVER COAL AREAS
43 CLARK-FORK COAL AREAS
44 CHISHOLM LAKE COAL AREA
45 KATHLYN LAKE COAL AREA
46 ZYMOETZ RIVER (COAL CREEK) COAL AREAS
47 KISPIOX RIVER COAL AREA
48 GROUNDHOG COAL AREA
NORTHWESTERN BRITISH COLUMBIA COAL DISTRICT (Atlin District)
49 STIKINE RIVER (TUYA RIVER) COAL AREA
50 TAKU RIVER COAL AREA
51 INKLIN RIVER COAL AREA
52 SLOKO RIVER COAL AREA
53 GRAHAM INLET COAL AREA
GROUNDHOG COAL AREA
PEACE RIVER COALFIELD
TELKWA COALFIELD
MERRITT COALFIELD
CUMBERLAND COALFIELD
NANAIMO COALFIELD
CROWSNEST COALFIELD
BRITISH COLUMBIA
ALBERTA
UNITED STATES
PACIFIC OCEAN
Queen Charlotte Islands
Vancouver
Victoria
Prince Rupert
Prince George
Edmonton
Calgary

The coal deposits of the Province are of the same three geological ages as the coals of Alberta, namely, Lower Cretaceous (some of which may be Jurassic), Upper Cretaceous and Tertiary. The most important deposits in the Province in respect both to present and potential development are those of Lower Cretaceous age. These include the deposits of the Crowsnest coal fields of southeastern British Columbia, the Peace River coal field of northeastern British Columbia, the Telkwa and Groundhog fields further to the west, and a number of small isolated deposits in northwestern British Columbia near the Alaska boundary. The only substantial production from these coal fields comes from the Crowsnest district. The coal mined in this district is of medium volatile bituminous rank. The coals of the other areas show wide range in rank. Those of the Peace River district are largely low volatile bituminous; those of the Telkwa district are mainly of high volatile bituminous rank; those of the Groundhog area are mainly low volatile coals; and the deposits of northwestern British Columbia are mostly lignitic coals.

The coal deposits of Upper Cretaceous age are restricted to Vancouver Island and Graham Island to the northwest. The coals of Vancouver Island are all of high volatile "A" bituminous rank. Those of Graham Island range from high volatile "A" bituminous rank to anthracite.

The Tertiary deposits are widely scattered throughout British Columbia and, with few exceptions, are of little economic significance. The locations of these are shown on the Map. In central and northern British Columbia, they consist of deposits of lignitic material which is either too unconsolidated or too thin to be mineable. The only deposit of any significance in this group occurs on Bowron River where three commercial seams of bituminous coal are believed to underlie an area of approximately 10 square miles. In southern British Columbia the Tertiary deposits occur in much larger basins and are more mature. These include the deposits at Hat Creek, Princeton, Merritt and Tulameen. The coals in these areas range in rank from lignite to bituminous.

In succeeding pages the important coal deposits of British Columbia will be discussed by districts.

Southeastern British Columbia

The coal fields of southeastern British Columbia occur near the Alberta border and extend for a distance of over 100 miles northward from the International Boundary. As will be seen from Map 11 these coal fields are divided structurally into three basins each containing a number of coal fields, the Flathead River coal fields in the south, the Crowsnest fields in the centre and the Upper Elk River coal fields in the north. Mining operations are at present confined to the Crowsnest basin, which is the largest producing coal area in British Columbia. Production is centred in two collieries of the Crow's Nest Pass Coal Company Limited located on the southern transcontinental line of the Canadian Pacific Railway near Fernie and at Michel. Until recently, mining operations were also conducted at Corbin, operations having commenced in that area in 1908.

The coals of southeastern British Columbia are of the same Lower Cretaceous geological age as those of the Inner Foothills belt of Alberta and formed part of the same deposit. It will be recalled from previous discussion of Alberta coal reserves, that the main development of the Kootenay coals of the Inner Foothills belt of Alberta occurred in this southeastern section of British Columbia.

At present the general structural trough in which occur the coal fields of southeastern British Columbia is separated from the Inner Foothills belt of Alberta by a four-mile wide belt of limestone that forms the front belt of the

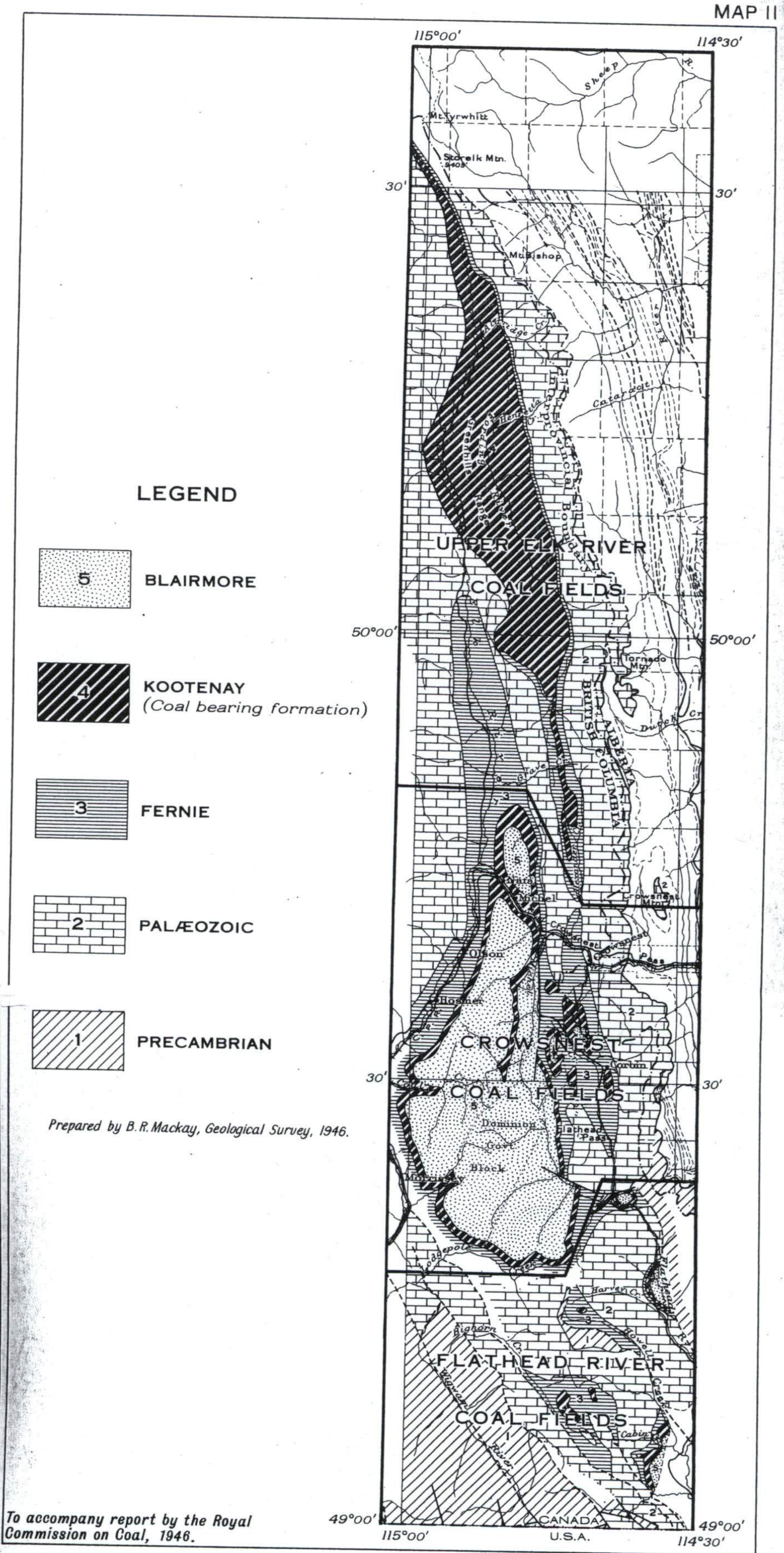
Rocky Mountains. This separation took place during the formation of the mountains, at which time the basin of deposition was cut by a major south-westerly dipping fault. Along this fault the portion of the basin lying to the west, with its underlying limestone beds, was thrust eastward and upward.

Folding and faulting within the basin in the British Columbia area has resulted in dividing the main structural trough in which the coal had been formed, into the three individual coal basins previously noted. As might be expected the rank of the coal in each of these basins is more or less similar and they are mainly of medium volatile bituminous rank. There is, however, a wide range in the characteristics of the coals. Some of the seams have a very low ash content, whereas others, notably the thick seams at Corbin, have a very high ash content. As in the instance of the coals of the Inner Foothills belt of Alberta, the coals are friable in areas where they have been subjected to faulting.

The central Crowsnest deposits are the most important in the area. As will be seen from Map 11 this area comprises the Fernie coal basin on the west and a group of smaller coal fields on the east, of which the Corbin area is the most important. The Fernie coal basin is the most important coal basin in British Columbia. It is a pear-shaped basin with its narrow portion to the north. It has a length of about 34 miles and a maximum width in the vicinity of Fernie of 12 miles, and covers an area of approximately 230 square miles all of which is underlain by coal. Sections measured at different areas in this basin have shown the presence of up to 23 seams of coal, 18 of which are over 3 feet in thickness. They have an aggregate thickness ranging from 100 to 172 feet. A vast proportion of this coal lies in the central portion of the basin beneath a great thickness of barren sandstones which forms the local plateau in this mountainous area. The coal measures are in turn underlain by a great thickness of soft marine shales. These have been deeply eroded by Elk River which runs along the west side of the basin. Thus the coal seams outcrop high up along the east side of the valley and are relatively inaccessible, except where tributary streams of Elk River have cut deep notches through the rim of the coal basin. Erosion in these fields has resulted in providing access to the seams at the valley level, thus not only facilitating mining operations but providing conditions for railway communication with the site of operations. The most favourable points of access from this point of view are found in the Michel Creek valley which is traversed by the Canadian Pacific Railway. The west side of the coal basin, along which the Canadian Pacific Railway line continues, provides only two further favourable conditions, namely, in the valleys of Coal Creek and Morrissey.

Mining experience has already established the fact that recovery is impractical in this locality much below a maximum cover of 2,500 feet, mining operations at that depth having been terminated because of the occurrence of "bumps". Except where Michel Creek has cut a wide valley across the basin to provide easy access to practically all of the seams, the available reserves of this field must be limited to the rim of the basin where the coal seams outcrop and lie within the limit of 2,500 feet of cover. Accordingly the estimate prepared for the Commission is confined to the coal lying within these limited areas. The dip of the seams varies according to location within the basin, and range from five to a maximum of 60 degrees. In the Michel area the dip is very moderate, whereas in the Fernie area the seams are inclined at about 30 degrees.

In the estimate prepared for the Commission which appears in Table 16, Appendix A, the reserves of mineable coal in this area are given as approximately 6,328,000,000 tons of probable coal and 1,860,000,000 tons of possible coal. It



COAL FIELDS OF SOUTHEASTERN BRITISH COLUMBIA is readily apparent, therefore, that this field has almost unlimited resources. The essential problem is accessibility and operational hazards due to accumulated mountain pressures. The abundance of the reserves in this area was illustrated to the Commission by the submission of the operating company in the field where, in respect to the two limited areas aggregating about 15 square miles, which form only a small part of their holdings, it was estimated that their reserves were as follows:

Assured	Probable	Possible
36,580,000 tons	70,490,000 tons	1,049,000,000 tons

It will be noted from the estimate covering the Crowsnest coal fields that the Corbin field has a very considerable reserve. This reserve is concentrated in Coal Mountain that has an area of less than 3 square miles, and consists of coal seams of remarkable thickness that have been subjected to intense folding, crushing and faulting. The estimate of 81,000,000 tons is based on a detailed investigation of this deposit by the Geological Survey in 1930. This estimate includes mineable rather than recoverable coal, but it is noted that operations were discontinued in 1933, and spur-line trackage subsequently torn up when less than 2,500,000 tons had been mined. The Commission is advised that although a large proportion of the underground reserves cannot be recovered, the Corbin field contains a large tonnage of readily mineable coal, a considerable portion of which might be recovered by open-cut operations.

The next most important group of coal fields in southeastern British Columbia are contained in the Upper Elk River basin which lies to the north of the Fernie basin. This basin has a similar north-south trend and extends for a length of about 50 miles and has a maximum width of about 10 miles. The area underlain by coal is estimated at over 125 square miles.

In this basin there are the same series of coal seams as occur in the Fernie basin but the deposits have been greatly eroded so that the reserves of the basin have been correspondingly reduced. Unlike the Crowsnest, the coal deposits of this Elk River basin are not characterized by a great depth of cover. Consequently the coal is more readily accessible from a point of view of mining operations. Assuming that mining operations can be conducted at 2,500 feet, much of the coal can be recovered. Development, however, is dependent on the construction of at least 35 miles of railroad, probably along the Elk River, from the nearest point of the Canadian Pacific Railway. The Commission is advised that the reserves of the area are most extensive, a reasonable approximation being 3,533,000,000 tons of probable coal and 2,458,000,000 tons of possible coal. A more detailed estimate appears in Table 16, Appendix A.

The remaining coal fields of southeastern British Columbia lie in the Flathead drainage basin and consist of a group of four small isolated deposits separated by barren rocks, the result of folding. Small mining operations have been carried on intermittently at some of these areas, but have since been terminated due to relative inaccessibility to markets. No railway communications exist in this area.

As will be seen from the estimate prepared for the Commission, the reserves of these coal fields are relatively small. In view of the more readily accessible reserves in the Crowsnest coal field, it is difficult to foresee their development beyond small scale mining for local purposes.

Northeastern British Columbia

The coal deposits of northeastern British Columbia are all of Lower Cretaceous age and occur in the Gething formation which is a northwestern extension of the Luscar formation of the Inner Foothills belt of Alberta. These deposits occur in the following seven areas—the Peace River Canyon, Butler Ridge, Carbon River, Falls Creek, Hasler Creek, Halfway-Sikanni Chief Rivers and Minaker River areas. The deposits of the Butler Ridge, Halfway-Sikanni Chief Rivers and Minaker River areas are of recent discovery arising out of geological mapping accompanying the construction of the Alaska Highway and little is known of their extent. The Carbon River deposit and its southeasterly extension at Falls Creek have been known for some time but no development work has taken place. Small scale operations commenced recently in the Hasler Creek area but generally mining has been confined to the Peace River Canyon area. In this area mining has taken place on the east and west sides of Portage Mountain which forms the southern extension of Butler Ridge. Production from these mines has been for local use mainly at Fort St. John about 50 miles to the east, but with the construction of the Alaska Highway, the local market has expanded to include Dawson Creek which is largely served from the Hasler Creek area.

The best exposure of the coal measures in this region occurs in the Peace River Canyon area, where the seams outcrop on the nose and both sides of an anticlinal fold that plunges to the south. The formation in this area is 1,400 feet in thickness and contains eight coal seams having average thicknesses ranging from 3 feet 5 inches to 5 feet 6 inches. The coal mined is of low volatile bituminous rank, and is of high grade.

It is apparent from the Commission estimate (see Table 17, Appendix A), that these northeastern British Columbia deposits contain large tonnages of good coal which will be available as this part of Canada develops.

Central British Columbia

The coal deposits of central British Columbia include the Lower Cretaceous deposits occurring in the Skeena River drainage basin with their main developments located in the Telkwa and Groundhog areas, and other Tertiary deposits occurring in the upper Fraser River basin centering in the Cariboo district. As previously noted the Tertiary deposits consist of numerous small isolated basin deposits, the majority of which are either too thin or inferior in quality, or of too small areal extent to warrant development under existing conditions. They consist largely of matted leaves and carbonized logs in thin seams interstratified through hundreds of feet of clays and sandstones. The deposit in the Bowron River area is an exception to this. This deposit which occurs on Bowron River in the Cariboo district some 30 miles east of Prince George, and some 15 miles west of the transcontinental line of the Canadian National Railways, contains three commercial coal seams measuring 4 feet, 7.5 feet and 9 feet, which are thought to underlie an area of about 10 square miles. The coal has been classified by the Provincial Government as bituminous coal.

The Lower Cretaceous coal deposits occur in a number of isolated basins some of which doubtless represent remnants of much more extensive deposits. Most of these are small deposits occurring in the Bulkley River area. The most important is the Telkwa deposit which has been under development for a number of years. The most extensive deposit of these Lower Cretaceous coals, however, occurs in the Groundhog area. Geographically, deposits of the central part of British Columbia are separated from those of northeastern British Columbia by a 180-mile belt of territory underlain by older rocks and the correlation of the coals of the two areas has not been established. Fossil evidence indicates a correlation with the Kootenay deposits of the Crowsnest districts of British Columbia and Alberta rather than with the Luscar formation of northwestern Alberta.

The Groundhog deposit lies in relatively unexplored rugged mountainous territory at the headwaters of the Skeena River. The nearest railway centre is some 150 miles to the south at Hazelton on the Canadian National Railways line to Prince Rupert. About 170 square miles of the Groundhog area are underlain by coal-bearing formations but the extent of the coal deposits is not known. Extensive prospecting of the Skeena River along its tributary streams has shown that the measures contain thirteen seams distributed through a stratigraphic interval of 1,240 feet, four of which are of commercial thickness. These seams measure 12 feet, 3 feet, 4 feet and 4 feet. The coal is largely low volatile bituminous and anthracite. The coal measures outside of this limited area are badly folded and faulted, and much of the area is inaccessible due to the mountainous terrain. A conservative estimate of the mineable reserves of the Groundhog area gives a total of nearly 900,000,000 tons of probable and possible coal. The possibilities of development in the area are conditioned by inaccessibility to markets.

In contrast the reserves of the Bulkley River coal deposits are more limited where they are more accessible, most of them being located close to the Canadian National Railways main line to Prince Rupert. The most important of these deposits lies in the Telkwa basin. This basin has an area of about 7 square miles underlain by coal-bearing rocks having a thickness of from 350 to 500 feet, and contain five seams, three of which are more than 3 feet in thickness. Over most of this area the coal measures are concealed by a heavy coat of alluvium and glacial drift, and the outcrops are confined largely to the immediate vicinity of Telkwa River and its tributary, Goat Creek. At these localities the coal seams generally have moderate inclination but in other places are folded or terminated by faults and cut by volcanic rocks. This folding and faulting and subsequent erosion has divided the Telkwa deposit into a number of small localized coal deposits, the extent of which is concealed by the thick cover of alluvium and glacial drift. This has presented serious problems in respect to mining and prevents any accurate assessment of the reserves without a programme of systematic drilling.

The coal mined in the Telkwa field is high grade high volatile "A" bituminous coal having a calorific value of 13,160 B.t.u./lb. The coal is of particularly hard structure.

The only other deposit in the Bulkley River area where mining has taken place is at Kathlyn Lake. The coal in this area is of anthracitic rank but only two seams are of commercial thickness and only limited mining is possible due to the folded, faulted and crushed conditions of the coal measures. Detailed estimates of these areas appear in Table 18, Appendix A.

Northern British Columbia

The coal deposits of northern British Columbia are of Lower Cretaceous and Tertiary ages. The Cretaceous coals are of high volatile "C" rank and the Tertiary coals are lignite. The location of these deposits is apparent from Map 10. The full extent of these deposits is not known but due to the low rank of the coal and their inaccessibility their significance is purely local. An estimate of the reserves of the area appears in Table 19, Appendix A.

South Central British Columbia

The coal deposits of south central British Columbia are all of Tertiary age and occur in numerous relatively small detached basins. They include the deposits in the Princeton, Tulameen, Merritt-Nicola, Quilchena, White Lake, Hat Creek, Kamloops and Chu Chua areas. Most of the deposits are of lignitic rank and apart from the Hat Creek area have little significance. At Hat Creek the deposit is of exceptional thickness. The deposit, however, is very impure and consists of interbedded lignite and clay. It outcrops at creek level but development has shown it to be highly folded, faulted and covered by volcanic rocks. It is possible that a large tonnage could be recovered by stripping operations.

The important deposits in this region occur in the Nicola Valley, Princeton and White Lake areas. In the former, mining operations have been carried on intermittently for the past 40 years, the principal operations being in the Diamond Vale section of the area. These operations have shown the existence of six coal seams of commercial thickness. About 38 square miles of the Nicola Valley are underlain by coal but most of this area lies in the centre of the basin beneath a great thickness of younger sediments and alluvium. The coal seams outcrop along the rim of this basin and dip toward its centre at angles up to 26 degrees. The coal ranks as high volatile "B" bituminous but is of low grade due to the presence of impurities interbedded in the coal seams and requires the installation of expensive washing and cleaning equipment in order to prepare the coal for market.

Small scale mining operations have been carried on in the Princeton field some 30 miles farther to the south for the past four years. At the present time only one company is operating in the area. The coals in this area range from lignite to sub-bituminous "A" and "B." This Princeton field consists of a basin deposit having a length of 14 miles and a width of from 3 to 6 miles and covering an area of approximately 50 square miles. The coal measures consist of sandstones and shales and contain at least four seams of commercial thickness, most of which lie within 300 feet of the surface. These measures are irregularly folded and cut by faults. Following the deposition of these coal measures they were overlain by flows of volcanic rock, remnants of which still conceal the coal measures along the rims of the basin, except where the flows have been cut through by the main streams. In many places these streams also cut their channels into the underlying coal measures and removed extensive areas of the uppermost coal seams. Over much of the basin a later deposit of glacial drift or alluvium ranging up to 25 feet in thickness conceals the coal measures, with the result that the outcrops of these measures are few and largely restricted to the channels of the main streams. These factors have been serious handicaps to geological investigations and mining development. Most of the known occurrences of coal within this basin have been prospected and the readily available coal of these locations has been mined. Further development of these deposits is dependent on new discoveries which will arise out of systematic drilling along the borders of the basin.

The White Lake field is a small basin deposit occurring on the western side of Okanagan Valley, 6 miles west of Okanagan Falls. The basin has an area of about 6 square miles and the measures contain at least two seams of bituminous coal of mineable thickness. Small scale mining for local consumption has been conducted intermittently in this area for the past 30 years.

Details of the reserves of these areas appear in Table 20, Appendix A. The reserves of the area as a whole are placed at approximately 279,000,000 tons of probable coal and about 140,000,000 tons of possible coal, about half of which is recoverable coal.

Vancouver Island

The coal deposits of Vancouver Island are all of Upper Cretaceous age and occur in the lower part of the Nanaimo series which has an average thickness of about 7,000 feet. These measures occur in five principal areas namely, Comox, Nanaimo, Suquash, Cowichan and Alberni. In the latter three areas the deposits are not commercial, the coal seams being either too thin or too dirty to permit profitable mining. There remains for consideration the Nanaimo and Comox areas. Mining operations have been conducted in these two areas for a long period. The main centres are Nanaimo in the first area and Cumberland in the Comox area. These lie respectively about 60 to 110 miles north of Victoria. The coal mined is of high volatile "A" bituminous rank.

The coal deposits of these two areas do not occur in the same geological horizon. Those of the Nanaimo area occur in the East Wellington and Newcastle formations in the lower part of the Nanaimo series, and are considerably older than those of the Comox area, which lie in the Comox formation, the equivalent of the sediment immediately overlying the Newcastle formation of the Nanaimo area. In the Comox area the coal-bearing formations of the Nanaimo area are missing, and the Comox formation rests directly on pre-Upper Cretaceous volcanic rocks. In both of these areas the coal-forming vegetation accumulated in lagoons and swamps along the sea coast, the greater part of the vegetation having been rafted into these areas. The resulting coal deposits are neither extensive nor uniform in thickness, but consist of irregular lense-like deposits of coal separated by deposits of clay interspersed with coal and barren areas. Each of these deposits in turn is characterized by clay partings and frequent occurrences of barren areas. In the Comox district these barren areas are extensive and are the result mainly of irregularities in the underlying volcanic rocks, which in places formed islands projecting above the swamps. In both areas smaller irregularities in the seam were caused by the erosion of streams which occurred during the formation of the bed rock. Folding and faulting has resulted in further variations in the thickness and attitude of the seams. Due to a thick covering of more recent sediments and of glacial drift, systematic drilling is necessary to locate and determine the extent of each of these deposits, and mining operations are necessarily expensive due to the combination of geological factors referred to above.

The coal measures in the Nanaimo basin underlie an area of approximately 100 square miles extending from the north shore of Departure Bay southward to include Gulf Island. However, only about 12 square miles in all is known to be underlain by coal seams having the minimum thickness required for mining operations in Vancouver Island. These occur within areas extending 10 miles south from Departure Bay to Nanaimo River, and from Extension Basin eastward to the submarine area of Northumberland Channel. There are four commercial coal seams in the area. Two of these having average thicknesses of 2 feet and 4 to 7 feet, occur at or near the top of the East Wellington formation about 700 feet above the base of the Nanaimo series. These seams outcrop in the western part of the Nanaimo area where they occur on the rims of shallow structural basins or in the flanks of anticlinal folds. They have been extensively mined in the vicinity of Extension and Northfield. The other two seams, having average thicknesses of 5 feet and 3 to 6 feet, occur in the Newcastle formation which lies 800 to 1,000 feet above the East Wellington formation. These seams outcrop in the eastern part of the field from the northern end of Newcastle Island southward along the coast line through Nanaimo to beyond South Wellington. They have been extensively mined at Nanaimo where the submarine workings extend beneath Nanaimo harbour. Limited work has been carried out at Nanaimo in respect to the lower seams of the East Wellington formation which in this area have a correspondingly gentle easterly dip.

Mining has been carried on in the Nanaimo field for more than fifty years and most of the known available coal has been recovered. Recent investigations of the Geological Survey indicate that the reserves in the area are only sufficient to allow operations to continue at the current level of production for from ten to fifteen years, after which production will be limited to the output of very small local mines. This is confirmed by the estimate of reserves submitted by Canadian Collieries (Dunsmuir) Limited, the principal operating company on Vancouver Island.

An analysis of the coal mined in this area appears below:

		(As received basis)
Moisture	Per cent	3.7
Ash	Per cent	10.7
Volatile Matter	Per cent	36.5
Fixed Carbon	Per cent	49.1
Sulphur	Per cent	0.4
Calorific Value	B.t.u./lb.	12,510
F.P.A.	°F	2,375

The coal deposits of the Comox area are distributed over a territory extending from T'Sable River northwest to Campbell River, a distance of about 45 miles, and inland from the coast for distances ranging from 2 to 13 miles. Less than a quarter of this area is believed to contain commercial coal which occurs in the following districts, the Cumberland, T'Sable River, Dove Creek-Brown's River, Tsolum River, Quinsam and Campbell River districts. These coal areas differ widely in size and in the extent of their reserves as will be seen from the Commission estimate. (See Table 21, Appendix A). They are separated from each other by extensive intervals of barren rock ranging from 2 to 7 miles.

Mining to date has been largely confined to the Cumberland area where ten or more seams occur, three of which have been workable. These workable seams range in thickness from 2.5 feet to 10 feet and vary greatly in quality. The mining centres are at Cumberland, Bevan and Puntledge. The seams in this area have been extensively worked and all the easily available coal has been mined. Future production will largely come from seams at depths of 1,000 feet or more.

The T'Sable River coal area lies to the southeast of the Cumberland coal field and is separated from it by five miles of non-coalbearing sediment. The area is an irregularly shaped basin-like deposit covering about 12 square miles. It extends from the T'Sable River northwest for a distance of four miles and has a width ranging from less than a mile to a maximum of four miles. A large amount of prospecting has been carried out in the area and has shown the coal to occur in at least five principal horizons each of which may consist of one or more seams. Three of these seams are workable having average thicknesses ranging from over 2.5 feet to over 11 feet. The coal measures lie with a general northeasterly dip averaging about 7 degrees. There has been some folding and faulting and the effect of this disturbance superimposed on initial irregularities of the seams arising out of the uneven topography on which they were laid down, has caused the coal to occur in more or less distinct basins. As will be seen from the estimate quoted above this area constitutes one of the most important proven coal reserves of the Comox area. Mining development work is now being undertaken at T'Sable River with a view to counterbalancing any decreases in production from the Nanaimo area.

The Dove Creek-Brown's River coal area embraces about two square miles, the centre of which lies about nine miles northwest of Comox. Coal occurs in the area in several seams which range in thickness from one to five feet. Some of them are well exposed on Brown's River and Dove Creek, and they have been intercepted by numerous bore-holes. In places the coal deposits have been rendered uncommercial by intrusions of volcanic rock. The Commission is advised that the company estimate of the reserves of this area is probably conservative.

Very little is known of the three remaining coal districts of the Comox region, namely, the Tsolum, Quinsam and Campbell River districts, which lie in large unexplored territory to the north at the headwaters of Tsolum River and on Quinsam River. Coal seams of commercial thickness outcrop along these rivers or their tributary streams and further prospecting has been carried on by diamond drilling. Access to these areas is available through the railway communications established by a number of logging and lumbering companies. It is possible that the company's estimate of reserves for these areas given above, may prove conservative.

Graham Island

Small coal deposits of both Upper Cretaceous and Tertiary ages also occur on Graham Island which is the most northerly of the Queen Charlotte Islands. The most important of these are those of Upper Cretaceous age which are found in five small basins in the southern part of the Island. The coal of these areas ranks generally as low volatile bituminous, some anthracite occurring in sections of the deposit which have been affected by volcanic intrusions. The coal seams of these deposits are seldom more than three feet in thickness and are badly folded and faulted. Mining has been carried on spasmodically for local consumption, the coal mined being generally of low grade due to high ash content. The Tertiary deposits occur along the northern coast of the Island, principally at Skonun Point. Up to 15 seams have been reported but they are generally thin and the quality of the coal is low grade lignite. The Commission is advised that the reserves of Graham Island have only limited significance due to difficulties in recovery arising out of the disturbance of the coal measures and the low grade of the coal. An estimate of the reserves appears on Table 22, Appendix A.

THE YUKON AND NORTHWEST TERRITORIES

The construction of the Alaska Highway, mining developments in the Yukon and in the Yellowknife district of the Great Slave Lake region of the Northwest Territories, and the increasing importance of the Polar areas in respect to aviation in recent years have directed attention to the possibilities of securing local supplies of coal in the Yukon and Northwest Territories, much of which is devoid of wood. In particular, the construction of the Alaska Highway through the southwestern section of the Yukon has brought a demand for coal in that area to supply wayside stations and the larger centres of population. The large-scale development in Yellowknife district has also created a local demand for both domestic and industrial fuel in the Great Slave Lake region. Trans-Polar and inter-continental aviation is demanding the establishment of meteorological stations in the Arctic Islands of the Northwest Territories. The possibilities of securing local supplies of coal will be a determining factor in the location of these establishments. Government stations at Pond Inlet on Baffin Island and at Aklavik on the Mackenzie River are supplied from local deposits of coal.

Comparatively little is known of the coal resources of the Yukon and Northwest Territories beyond where actual mining operations have taken place or where outcrops of coal seams and "float-coal" have been observed.

With the exception of the vicinity of the Whitehorse-Dawson road, exploration in the Yukon has been largely confined to the major stream courses whereas, in the Arctic Islands, exploration has been mainly restricted to the areas in the immediate vicinity of the coast lines.

The Yukon

The coal deposits of the Yukon are extensive and widely distributed. These deposits are largely of Lower Cretaceous and Tertiary ages, those of the earlier Cretaceous age being the most important. These are largely confined to the drainage basin of Lewes River and have been mined principally at Tantalus in the Carmacks district. Further deposits occur to the south of this district, in the Laberge, Aishihik and Whitehorse areas, and to the north in the Arctic coast area. A small mine is in operation in the Arctic area at Moose River as a source of supply for the Government station at Aklavik. The coals of these areas are largely of high and medium volatile bituminous rank but range from lignites to low volatile bituminous.

The coals of Tertiary age, which are all of lignitic rank, have been extensively mined in the Dawson district, but are known to occur in mineable seams in the Ogilvie, Kluane, Kaskawulsh, Dezadeash and Watson Lakes districts to the south and southeast and in the Bonnet Plume district to the northeast.

A preliminary estimate of the coal reserves of the Yukon Territory appears in Table 23, Appendix A, and gives a total of nearly 2,000,000,000 tons of probable and possible mineable coal. The figures are of necessity approximations but they are sufficient to indicate that, with few exceptions, the reserves are sufficient to meet the increasing demand which may be expected with the development of the Yukon.

The Northwest Territories

The coal deposits of the Northwest Territories are of three geological ages, Tertiary, Lower Cretaceous and Carboniferous, and the coals range in rank from lignite to bituminous. Very little is known of the extent of the deposits due largely to the unexplored nature of this part of Canada.

The Tertiary deposits are found at Fort Norman on Mackenzie River, in the centre of Banks Island and at numerous points along the west and northeast coasts of Ellesmere Island, on the west coast of Bylot Island and at Pond Inlet at the mouth of Salmon River on the north coast of Baffin Island. Mining has been confined to a small operation at Pond Inlet, where the coal is of good grade lignitic or sub-bituminous rank.

The known deposits of Lower Cretaceous age are confined to five localities in the Mackenzie River Basin, namely, Liard River, Great Bear Lake, the west channel of Mackenzie River, the west shore of Franklin Bay and the adjacent Langton Bay. No mining has been carried on in these areas. Analysis of samples of the coals indicates that they are of lignitic rank.

Coal of Carboniferous age, largely in the form of "float-coal", has been reported from more than twenty-eight localities along the coast lines of the central Arctic Islands, extending from Prince Patrick Island on the west to Graham Island on the east and from the northeast coast of Banks Island on the south to the northern end of Axel Heiberg Island. These localities occur over an area measuring 500 miles in length and 250 miles in breadth. Bituminous seams up to 25 feet in thickness have been reported by explorers in some of these localities and have served as sources of fuel supply for various expeditions. The existence of coal deposits in these Arctic Islands is of strategic importance in respect to Arctic exploration and the development of inter-continental air communications. A preliminary estimate of the reserves of the Northwest Territories appears in Table 24, Appendix A. This estimate places the reserves at about 2,500,000,000 tons of probable and possible mineable coal.

OWNERSHIP OF COAL AND MINING RIGHTS

Ownership of Canada's coal resources is divided between the Dominion Government, the Provincial Governments, and private interests. Ownership of coal rights by the Dominion Government is confined to the Yukon and Northwest Territories, two areas in the Crowsnest in southeastern British Columbia and the National Parks. Some of the land grants in the Yukon and Northwest Territories carry coal rights. Where the rights remain with the Crown, access is provided on the basis of rental of $1.00 per acre and a royalty of 5 cents a short ton. With few exceptions, for example, Indian Reserves, where coal is the property of the Indians, coal rights in respect to the remaining parts of Canada fall under provincial jurisdiction. The distribution of ownership of coal rights varies according to provinces, one essential feature being that the Maritime Provinces of Nova Scotia and New Brunswick have clear title to their coal resources, whereas the Western Provinces share ownership with private interests.

Nova Scotia and New Brunswick held the coal rights of their respective provinces at the time of Confederation, and none of the coal has been alienated from the Crown in the right of the provinces since 1867. In the Western Provinces coal rights over substantial areas are held by the Hudson's Bay Company, the Canadian Pacific Railway Company, and a number of corporate and individual interests. This alienation of the coal resources from the Crown is derived from a long period of history in which, with the exception of British Columbia, the provincial governments have played a very minor role until 1930 when ownership of the natural resources was finally transferred from the Dominion Government to the provinces.

British Columbia at the time of its entry into the Union had jurisdiction over its natural resources. Subsequent to 1870 British Columbia placed at the disposal of the Dominion Government large land areas, commonly referred to as the "railway belt" and "Peace River block," in connection with the construction of the Canadian Pacific Railway Company's transcontinental line to the Pacific Coast and the development of the Peace River district. The coal mining rights of extensive areas in these two districts were alienated from the Crown prior to 1930, at which time the resources of these areas which had not been alienated were returned to the Province. A further tract of land comprising some 3,000 square miles in the southeasterly portion of Vancouver Island was placed under Dominion control by 47 Victoria, Chapter 14, Statutes of British Columbia, to aid in the construction of the Esquimalt and Nanaimo Railway. The lands in this tract, including coal rights, were transferred by the Dominion to the Railway Company in 1887 and 1905. Prior to 1899 coal rights were not reserved by the Province in grants of Crown lands, and in the interval between 1899 and 1944, coal rights were not always reserved in such grants. Since 1944 the Province has discontinued the practice of granting or selling coal rights and has provided access to its coal deposits on the basis of rentals and royalties.

Manitoba, Saskatchewan and Alberta originally formed part of Rupert's Land and the Northwest Territories, control of which came under the jurisdiction of the Governor and Company of Adventurers of England trading into Hudson's Bay (generally known as the Hudson's Bay Company) by right of English Charter. In 1870 the Dominion Government entered into an agreement with the Hudson's Bay Company whereby Canada gained possession of these territories. Under the terms of this agreement the Hudson's Bay Company retained ownership, including the mineral rights, of about 5 per cent of the lands within the "fertile belt" in these territories, the belt being defined in the agreement. Mineral rights covering large areas in these Western Provinces were also alienated from the Crown arising out of land grants to the Canadian Pacific Railway and other railway companies. Saskatchewan, Alberta and Manitoba did not acquire ownership of their resources at the time of their entrance into the Union, these being acquired in 1930. By that time further alienations of coal rights from the Crown had taken place in these territories. This alienation was associated with land grants designed to assist in the opening up of the "West", and included military bounty grants, school land sales, and homestead grants, the latter being the largest factor. Until 1887 conveyances of homestead lands and other Crown granted lands carried mineral rights. Subsequently coal rights were not carried automatically, but could be purchased for a nominal sum. After 1901 any such purchase did not relieve the owner from paying royalties on any coal mined. From 1907 sales of coal rights were largely discontinued, access to the Crown coal lands being provided by lease on the basis of rentals and royalties. The following information in respect to alienation of coal rights in Alberta prior to 1930 was submitted by the Alberta Government:

Nature of Grant	Acreage	
	No Royalty	Subject to Royalty
Subsidies to Railways	13,031,731.00	
Subsidy to Hudson's Bay Company	2,404,000.00	
Coal Lands Sales, Mining Lands Sales, and Mineral Sales	46,724.44	189,201.99
Unpatented Mineral Sales	....	370.40
Patented after September 1, 1905		
Homesteads	3,007.46	
Special Grants	21,165.73	
Right of Way and Station Grounds	44.79	
Pre-emptions	2,190.52	
Small Lands Sales of Various Kinds	5,817.08	
Military Homesteads, Military Bounty Grants, and North West Mounted Police Grants	647.00	
School Lands Sales	151.01	
Homesteads, etc., patented before September 1, 1905, approximately	250,000.00	
	15,765,479.03	189,572.39

Full particulars of the position in respect to Saskatchewan and Manitoba are not available. It would appear from the limited information available that the position in these provinces was reasonably comparable. This is suggested by the evidence submitted to the Commission by the Saskatchewan Government relating to the Estevan coal field. This coal field covers an area of some 65,920 acres. In 1930 the Province obtained the coal rights on 26,530 acres or 40.3 per cent. Coal rights on the remaining 39,390 acres or 59.7 per cent had been alienated. The coal rights disposed of through mineral sales affect approximately 5,630 acres. A review of the mineral titles in the area reveals the ownership of coal rights in February, 1945, to be as follows:

Crown Coal Rights	Individuals	C.P.R.	Man. & Sask. Coal Co.	West. Dom. Coal Co.	H.B. Co.	Total
Acres	Acres	Acres	Acres	Acres	Acres	Acres
26,530	15,163	12,027	5,800	4,480	1,920	65,920
Per cent 40.3	Per cent 23.0	Per cent 18.2	Per cent 8.8	Per cent 6.8	Per cent 2.9	Per cent 100.0

Thus in review the Dominion Government holds clear title to all coal rights in the Yukon and Northwest Territories, and Nova Scotia and New Brunswick occupy similar positions in respect to their provincial resources. No precise statement can be given of the division of ownership of coal rights in the Western Provinces. These rights have been extensively alienated from the Crown and only a detailed survey can unravel the intricate pattern of ownership which has arisen out of the long history and innumerable transactions of land and mineral ownership over many generations. In recent years these provinces have been attempting to clarify the position for themselves, and it appears that Alberta and Saskatchewan are making efforts to recover ownership and control of their coal resources.

Various statutes and regulations in each of the provinces concerned provide for control of mining rights in respect to Crown owned coal resources. Under this legislation access to such coal resources is provided for on the basis of rentals and royalties. Provision is also made for the inspection of mining plans in order to ensure orderly development and maximum recovery of coal by the lessee. The legislation usually provides for control of sub-leasing arrangements, but it does not appear that these provisions are energetically applied. Normally, provision is made for short term prospecting permits with mining leases covering a longer term, usually about 20 years. Nova Scotia has leased considerable areas for a 99-year period with right of renewal for a further 20 years. These leases are held by constituent companies of the Dominion Steel and Coal Corporation Limited. By special arrangement effected in 1892, the Dominion Coal Company Limited and Nova Scotia Steel and Coal Company Limited hold 97 square miles of coal lands on this basis, and the Acadia Coal Company holds a further 19 square miles in the Pictou area on similar terms. The four constituent coal companies hold mining rights covering some 544 square miles, more particulars of which are as follows:

COAL LANDS IN NOVA SCOTIA HELD UNDER LEASE BY SUBSIDIARY COMPANIES OF DOMINION STEEL AND COAL CORPORATION LIMITED

Area	Dominion Coal Co. Ltd.	Cumberland Railway & Coal Co. Ltd.	Nova Scotia Steel & Coal Co. Ltd.*	Acadia Coal Co. Ltd.	Total
	sq. miles	sq. miles	sq. miles	sq. miles	sq. miles
Cape Breton	266	13	95	.....	374
Pictou	.....	.....	3	19	22
Cumberland	.....	148	.....	.....	148
Total	266	161	98	19	544

* Not an operating Company. Leases in Sydney coalfield are operated by Old Sydney Collieries Limited, a subsidiary Company of Dominion Steel and Coal Corporation Limited, on payment of 10 cents a long ton royalty.

In New Brunswick the ownership of mining rights in the Minto coal field is divided among some 32 different lessees and this fragmentary ownership would not appear to be in the best interests of the Province or the coal mining industry. Elsewhere information is not readily available as to the extent to which mining rights are held on Crown owned coal resources.

Each of the coal producing provinces imposes charges on coal mined in the province either in the form of royalties or taxation. In Nova Scotia a rental charge of $30.00 a square mile and a royalty of 12½ cents per long ton is charged on all coal mined with the exception of coal used for domestic purposes by mine workers or in mining operations. Royalty payments are a credit on rentals. In New Brunswick the rental charge is $10.00 per 40 acres, and the royalty 9 cents per short ton. Royalty payments again are a credit on rental. In Manitoba, Saskatchewan and Alberta the rental charge is $1.00 per acre and the royalty 5 cents per short ton. Minor exceptions are made in respect to production for domestic purposes only, where the royalty is 25 cents a short ton in Saskatchewan and 10 cents in Alberta. In addition these provinces receive 7 cents a ton royalties on coal mined in lands alienated from the Crown by mineral sales. Saskatchewan in 1944, and Alberta in 1945, applied mineral taxation to privately owned coal rights, Alberta imposing a tax of 1 cent per acre and Saskatchewan a tax of 3 cents per acre; both Governments are also empowered to impose a further tax, in Alberta up to 10 mills on the assessed value of coal located in a producing area, in Saskatchewan up to 10 mills on coal lands where mining is being carried on, and 50 cents per acre on non-productive land in producing areas. In addition to providing revenue this legislation has in mind provincial acquisition of mineral resources by forfeiture of mineral rights for non-payment of tax. In British Columbia the rental is $1.00 per acre and the royalty 25 cents per short ton on coal shipped. Crown granted lands assessed as coal lands and under mining development are taxed at 1 per cent of assessed value. Similar lands not under mining development are taxed at 2 per cent of assessed value. There are some 256,438 acres in the first class, and 101,891 acres in the second. A tax of 10 cents a long ton is charged on all coal shipped irrespective of the ownership of the coal rights. This tax does not apply where the provincial royalty is payable or to coal used in the manufacture of coke. Coke oven operators pay 10 cents a long ton on the coke. In both cases this tax is alternative to provincial income tax.

WORLD RESERVES AND RESERVES OF COUNTRIES SUPPLYING CANADIAN MARKET

World Reserves

Very little information is available in respect to world resources of mineable coal. Some idea of the distribution of coal resources can be gathered from the estimates prepared by the Twelfth International Geological Congress in 1913. According to these estimates, coal resources were distributed between the various continents as follows:

	Net tons
Americas	5,627,823,500,000
Asia	1,410,487,600,000
Europe	864,412,600,000
Oceania	187,842,900,000
Africa	63,755,900,000
Total	8,154,322,500,000

It will be seen that, according to these estimates, the American continent possesses nearly 70 per cent of world coal resources. When related to rank, Asia was estimated to have about 80 per cent of world resources of anthracite, and the American continent to have over 70 per cent of bituminous and lignite resources. It will be noted from the following breakdown of the estimate by countries that the United States was considered to have about 52 per cent of the total resources, and Canada to hold second place with about 16 per cent. United States was estimated to have 76 per cent and Canada 24 per cent of the resources of North America.

	Net tons
United States, including Alaska	4,231,352,000,000
Canada	1,360,535,000,000
China	1,097,436,000,000
Germany	466,665,000,000
Great Britain and Ireland	208,922,000,000
Siberia	191,667,000,000
Australia	182,510,000,000
India	87,083,000,000
U.S.S.R. in Europe	66,255,000,000
Union of South Africa	61,949,000,000
Austria	59,387,000,000
Colombia	29,762,000,000
Indo-China	22,048,000,000
France	19,382,000,000
Other countries	69,369,500,000
Total	8,154,322,500,000

Since 1913, various countries have re-estimated their reserves. Russian reserves in 1934 were reported at 1,100 billion tons as against 400 billion tons previously estimated. German estimates were also increased. The United States reserves, on the other hand, were placed in 1942 as 3,178,000,000,000 tons as compared with the previous figure of 4,231,352,000,000 tons. It will be noted that the Commission estimate of Canadian reserves scales down the 1913 estimate from 1,360,535,000,000 tons to approximately 100,000,000,000 tons.

These revisions are, to some extent, the result of the accumulation of new data. In regard to the Commission estimate of Canadian reserves, however, the revision represents the application of totally different yardsticks in the determination of reserves in order to ascertain the extent of known reserves of coal which are available for mining under existing conditions. Thus the figures of this estimate cannot be used for comparative purposes with respect to reserves of other countries. As previously noted, the yardsticks used by the Geological Congress in 1913 were not calculated to yield estimates of mineable or recoverable coal. They are, however, useful in giving some idea of the distribution of coal occurrences throughout the world.

Reserves of Countries Supplying Canadian Market

The principal interest of this Commission in coal reserves outside of Canada relates to the ability of various countries to continue as sources of supply to the Canadian market. From this point of view, interest is concentrated in the reserves of the United States and to a lesser extent, of Great Britain. This is apparent from an analysis of sources of supply to the Canadian market. In 1939, 99 per cent of the imported bituminous coal consumed in Canada came from the United States. Sixty-six per cent of imported anthracite in 1939 came from the United States; and 26 per cent, from the United Kingdom. A further 7 per cent came from Germany. During recent war years the percentage of anthracite imported from the United States increased to nearly 95 per cent. In substance, therefore, our concern is with the United States' reserves of bituminous coal and the United States' and the United Kingdom's reserves of anthracite coal.

UNITED STATES RESERVES

As will be seen from Map 1, the coal deposits of the United States are widely distributed, and large areas of coal lands are present in or near all parts of the country except the Pacific coast region. It is also apparent that the deposits include a variety of coals ranging from anthracite to lignite. In general the western deposits are of low rank, the higher rank coals being largely concentrated in the East. The lower rank coals of the West constitute a large proportion of the United States reserves. Anthracite deposits are largely concentrated in eastern Pennsylvania although small amounts of anthracite and semi-anthracite are mined in other areas. About 70 per cent of the bituminous coal production comes from the Appalachian area which extends from Pennsylvania and Ohio to northern Tennessee. Here also are found the larger tonnages of the better grades of bituminous. Most of the coal shipped to Canada originates in this area. The mid-western fields of Illinois, Indiana, Iowa and West Kentucky, however, are important producers and account for approximately 20 per cent of the total United States output. Relatively large tonnages of Canadian railway fuel were supplied from these fields during the war.

According to the United States Bureau of Mines Information Circular I.C. 7261, November, 1943, the United States reserves of mineable* coal were as follows at January, 1942:

Rank of Coal	Reserve January 1, 1942 (net tons)
Anthracite	15,000,000,000
Low Volatile Bituminous**	53,000,000,000
High Volatile Bituminous**	1,353,000,000,000
Sub-bituminous	818,000,000,000
Lignite	939,000,000,000
Total, all ranks	3,178,000,000,000

In respect to bituminous coal, the principal sources of Canadian supply are United States coal districts 1, 2, 3, 4, 6 and 8 which are, in the same order, Central Pennsylvania, Western Pennsylvania, Northern West Virginia, Ohio, West Virgina Panhandle, and Southern High Volatile. Southern High Volatile district embraces Southern West Virginia, Virginia, Eastern Kentucky and Tennessee. These districts contain over 40 per cent of the bituminous coal reserves of the United States.

During the course of the Commission's enquiry, a number of the principal operators in these districts, who supply Canada with more than 50 per cent of the total imported United States bituminous coal, assured the Commission that the reserves of available bituminous coal are almost unlimited, and that there need be no anxiety in Canada as to a continuous supply of high grade bituminous coals from the United States.

Elsewhere in the report reference is made to the anxiety which was felt both in the United States and Canada in the early 'twenties regarding the adequacy of anthracite reserves in the United States. During the course of our enquiry, the Commission has received adequate assurances from the Federal Bureau of Mines, the Topographic and Geologic Survey of the Commonwealth of Pennsylvania the chief source of supply of United States anthracite to the Canadian market, and the anthracite operators themselves to the effect that the anthracite reserves are adequate to assure continued supply at the current level of production for more than one hundred years. According to the Commonwealth Topographic and Geologic Survey, Pennsylvania in 1945 had anthracite reserves in excess of 15,000,000,000 short tons. There is some evidence, however, to show that mining costs are increasing in the anthracite industry. The coal presently mined is deeper and in underground mining to-day 20 tons of water must be raised for every ton of coal. The thicker seams are being exhausted and the thinner seams are now being mined. It is possible, therefore, that while supplies may be adequate, the price of anthracite may increase.

UNITED KINGDOM ANTHRACITE

Various estimates of United Kingdom coal reserves have been made. Based on seams 12 inches or more in thickness and within 4,000 feet of the surface, the estimates have varied between 131,000 million and 190,000 million long tons. A preliminary appraisal of the findings of a very recent survey of United Kingdom

* Basis of estimate was minimum thickness of 14 inches for bituminous and anthracite, 2 feet for sub-bituminous and 3 feet for lignite, with a maximum depth of cover of 3,000 feet. Specific gravity was assumed to be 1.3.

** Includes some medium volatile coal.

reserves appears in Survey Paper No. 58, 1946, Department of Scientific and Industrial Research. This survey, known as the "Rapid Survey," was restricted to coal likely to be mined during the next 100 years. The following is extracted from Survey Paper No. 58:

Type of Coal	Developed reserves (=Total planned output for 1942–2042)		Projected annual output (Average, 1942–52)	
	Millions of long tons	Per cent	Millions of long tons	Per cent
Anthracite	704.6	3.4	8.239	3.5
Low- and medium-volatile steam coals	1,861.9	9.1	22.086	9.3
Medium-volatile coking coals	1,556.2	7.6	22.229	9.3
High-volatile strongly caking and medium caking coals, i.e. coking-gas and gas coals	7,402.3	36.1	88.016	37.0
High-volatile weakly caking coals	2,894.4	14.1	33·513	14.0
High-volatile very weakly caking and non-caking coals	5,634.1	27.5	63.391	26.6
Unclassified	446.9	2.2	0.671	0.3
Total	20,500.4	100.0	238.145	100.0

A considerable percentage of anthracite produced in Great Britain came to the Canadian market in normal years before the war, and it is clear from the estimate that the reserves are sufficient to allow the United Kingdom to continue to supply the Canadian market. It is not clear from the present condition of the industry in the United Kingdom that Canada can rely on a continuous supply of anthracite at pre-war prices.

CHAPTER II

HISTORY OF PRODUCTION

This chapter contains a brief history of coal production in Canada. It is designed to provide background helpful in understanding current problems of the industry. In general, the method followed is first to review production statistics for the country as a whole, and then to review production statistics for the coal producing provinces. Within the Province of Alberta and British Columbia, some attention has been paid to individual regions. Considerable attention has also been given to the influence of exports on production.

Total production prior to Confederation was 3,000,000 tons. Somewhat more than three-quarters of this tonnage was mined in the Maritime Provinces, principally on Cape Breton Island; the remainder came from Vancouver Island. At Confederation total Canadian production was slightly over 600,000 tons per year. Production from 1867 to 1944 has been as follows:

Year	Short Tons	Year	Short Tons	Year	Short Tons
1867	631,320	1893	3,783,499	1919	13,919,096
1868	623,392	1894	3,847,070	1920	16,946,764
1869	687,825	1895	3,478,344	1921	15,057,493
1870	752,635	1896	3,745,716	1922	15,157,431
1871		1897	3,786,107	1923	16,990,571
1872	3,033,152	1898	4,173,108	1924	13,638,197
1873		1899	4,925,051	1925	13,134,968
1874	1,063,742	1900	5,777,319	1926	16,478,131
1875	1,039,974	1901	6,486,325	1927	17,426,861
1876	994,762	1902	7,466,681	1928	17,564,293
1877	1,036,670	1903	7,960,364	1929	17,496,557
1878	1,089,744	1904	8,254,595	1930	14,881,324
1879	1,126,497	1905	8,667,948	1931	12,243,211
1880	1,482,714	1906	9,762,601	1932	11,738,913
1881	1,537,106	1907	10,511,426	1933	11,903,344
1882	1,848,148	1908	10,886,311	1934	13,810,193
1883	1,818,684	1909	10,501,475	1935	13,888,006
1884	1,984,959	1910	12,909,152	1936	15,229,182
1885	1,920,977	1911	11,323,388	1937	15,835,954
1886	2,116,653	1912	14,512,829	1938	14,294,718
1887	2,429,330	1913	15,012,178	1939	15,692,698
1888	2,602,552	1914	13,637,529	1940	17,566,884
1889	2,658,303	1915	13,267,023	1941	18,225,921
1890	3,084,682	1916	14,483,395	1942	18,865,030
1891	3,577,749	1917	14,046,759	1943	17,859,057
1892	3,287,745	1918	14,977,926	1944	17,026,499

SOURCE.—Coal Statistics for Canada.

For Canada as a whole, production figures show a steady growth, interrupted only three times: at the beginning of the first World War, in the mid 'twenties, and by the depression of the 'thirties. A substantial degree of recovery from the low production levels of the depression years had already been achieved when World War II started, and new all-time peaks in production were achieved during the war years.

For the past thirty-five years, however, this growth has been almost entirely the result of expansion in Alberta and Saskatchewan. The trend of production in New Brunswick has been generally upwards since 1910, but the tonnages involved are small. Nova Scotia production reached its peak in 1931; the highest production achieved in the recent war years was still below the levels attained thirty years previously. British Columbia reached its highest production in 1910.

Export figures covering the period 1873 to date are as follows:

Year	Short Tons	Year	Short Tons	Year	Short Tons
1873	420,683	1897	986,130	1921	1,987,251
1874	310,988	1898	1,150,029	1922	1,818,582
1875	250,348	1899	1,293,169	1923	1,654,406
1876	248,638	1900	1,787,777	1924	773,246
1877	301,317	1901	1,573,661	1925	785,910
1878	327,959	1902	2,090,268	1926	1,028,200
1879	306,648	1903	1,954,629	1927	1,113,330
1880	432,188	1904	1,557,412	1928	863,941
1881	395,382	1905	1,635,287	1929	842,972
1882	412,682	1906	1,835,041	1930	624,512
1883	486,811	1907	1,894,074	1931	359,853
1884	474,405	1908	1,729,833	1932	285,487
1885	427,937	1909	1,588,099	1933	259,233
1886	520,703	1910	2,377,049	1934	306,335
1887	580,965	1911	1,500,639	1935	418,391
1888	588,627	1912	2,127,133	1936	411,574
1889	665,315	1913	1,562,020	1937	355,268
1890	724,486	1914	1,423,126	1938	353,181
1891	971,259	1915	1,766,543	1939	376,203
1892	823,733	1916	2,135,359	1940	504,898
1893	960,312	1917	1,733,156	1941	531,449
1894	1,103,694	1918	1,817,195	1942	815,585
1895	1,011,235	1919	2,070,050	1943	1,110,101
1896	1,106,661	1920	2,558,174	1944	1,010,240

SOURCE.—Coal Statistics for Canada.

It will be noted that a general expansion of exports took place until the turn of the century, and exports then continued in the general range of 1,500,000 to 2,000,000 tons per annum until after the end of the first World War, although with marked fluctuations occurring from year to year. In 1920 exports reached their all-time peak of over 2,500,000 tons, following which there was a steady recession to a low of 259,000 tons in 1933. Exports did not rise much above 400,000 tons until the war years.

In 1875 exports took 25 per cent of Canadian production; in 1900 over 35 per cent. A steady decline then started, and by 1910 about 20 percent of production went to export markets, by 1920 only 15 per cent, and in 1930 barely over 4 per cent. In 1933 exports took only 2.2 per cent of Canadian output, and until the start of the war did not take over 6 per cent in any succeeding year.

The origin of coal for Canadian consumption is shown by the following table:

Year	Canadian		Imported	
	Short Tons	Percentage	Short Tons	Percentage
1902	5,376,413	53.1	4,734,559	46.9
1903	6,005,735	47.3	6,678,450	52.7
1904	6,697,183	47.9	7,297,482	52.1
1905	7,032,661	49.4	7,215,446	50.6
1906	7,927,560	50.5	7,758,325	49.5
1907	8,617,352	45.0	10,549,503	55.0
1908	9,156,478	47.3	10,195,424	52.7
1909	8,913,376	47.9	9,711,826	52.1
1910	10,532,103	50.2	10,438,123	49.8
1911	9,822,749	40.5	14,424,949	59.5
1912	12,385,696	46.0	14,549,104	54.0
1913	13,450,158	42.6	18,132,387	57.4
1914	12,214,403	45.5	14,637,920	54.5
1915	11,500,480	48·1	12,406,212	51.9
1916	12,348,036	41.3	17,517,820	58.7
1917	12,313,603	37.2	20,810,132	62.8

Year	Canadian		Imported	
	Short Tons	Percentage	Short Tons	Percentage
1918	13,160,731	37.8	21,611,101	62.2
1919	11,611,168	40.3	17,236,269	59.7
1920	14,025,566	42.9	18,668,741	57.1
1921	12,715,734	41.1	18,258,387	58.9
1922	13,044,352	50.2	12,962,189	49.8
1923	15,070,962	41.8	20,967,971	58.2
1924	12,529,358	42.8	16,714,143	57.2
1925	12,125,290	42.6	16,331,971	57.4
1926	15,086,296	47.7	16,565,555	52.3
1927	15,944,983	46.7	18,177,303	53.3
1928	16,487,807	50.0	16,515,582	50.0
1929	16,387,461	48.0	17,724,132	52.0
1930	14,052,671	43.3	18,412,039	56.7
1931	11,682,779	47.7	12,828,327	52.3
1932	11,212,701	49.0	11,654,492	51.0
1933	11,456,273	51.5	10,808,962	48.5
1934	13,236,406	51.1	12,651,168	48.9
1935	13,306,303	53.1	11,735,835	46.9
1936	14,508,652	53.3	12,719,515	46.7
1937	15,172,729	51.5	14,268,585	48.5
1938	13,800,094	52.3	12,573,872	47.6
1939	14,902,915	50.6	14,564,679	49.4
1940	16,666,234	49.5	17,036,090	50.5
1941	17,227,151	46.2	20,026,082	53.8
1942	17,725,761	42.0	24,529,361	58.0
1943	16,321,006	37.1	27,695,098	62.9
1944	15,660,808	35.7	28,166,201	64.3

SOURCE: Coal Statistics for Canada.

The point of primary interest in these figures is that the Canadian production has for the past forty years held a remarkably constant proportion of the Canadian coal market. The only two periods of sharp divergence from the general pattern have been in the two periods of war when the demands of industry increased the proportion of United States coal used in the country, and the proportion of the demand filled by Canadian production was approximately the same in each of these war periods. In the years immediately preceding World War II Canadian production met a larger proportion of Canadian demands than at any time in the past forty years.

It is of interest to note the position of Canada as a coal producer relative to the other coal producing areas of the world. Information is not readily available for years since the start of the war, but in 1938 the total Canadian production of 14,295,000 tons can be compared with a world production in excess of 1,400,000,000 tons. In that year the principal producing countries were Germany (397,000,000 tons), United States (349,000,000 tons), Great Britain (227,000,000 tons), and Russia (130,000,000 tons). During the war years United States production grew to over 650,000,000 tons per annum. By far the greater portion of world production is bituminous coal, upon which practically the entire industrial development of such countries as the United States, Great Britain, and Germany has been based. Canadian production is largely bituminous, with the remainder being sub-bituminous or lignite.

NOVA SCOTIA

Although mining was carried on intermittently from 1720, it was not important until the General Mining Association commenced operations in 1830. The mining industry of Cape Breton did not develop as well as anticipated, and in 1857 production was only 117,000 tons. In that year the Government of Nova

Scotia acquired the ownership of mineral rights previously held by the General Mining Association, and in the succeeding years several new mines were opened.

The bulk of Nova Scotia production is from Cape Breton Island; there is also production on the mainland of Nova Scotia in Cumberland and Pictou Counties. A detailed record of production and exports of Nova Scotia coal follows. For the year 1901 to date, production is shown by areas, as well as for the Province as a whole:

PRODUCTION—NOVA SCOTIA—1785-1900 AND EXPORTS 1874-1900

Date	Production	Exports	Date	Production	Exports
1785-1866	2,649,416	....	1884	1,556,011	222,709
1867	596,332	....	1885	1,514,470	176,287
1868	574,106	....	1886	1,682,924	240,459
1869	647,727	....	1887	1,871,330	207,941
1870	719,211	....	1888	1,989,263	165,863
1871	754,827	....	1889	1,967,032	186,608
1872	986,664	....	1890	2,222,081	202,387
1873	1,177,643	....	1891	2,290,158	194,867
1874	977,446	252,124	1892	2,175,913	181,547
1875	874,905	179,626	1893	2,489,807	203,198
1876	794,804	126,520	1894	2,520,707	310,277
1877	848,398	173,389	1895	2,239,727	241,091
1878	863,075	154,114	1896	2,537,706	380,149
1879	882,863	113,742	1897	2,020,835	307,128
1880	1,156,635	119,552	1898	2,584,175	309,158
1881	1,259,183	193,081	1899	3,209,296	459,260
1882	1,529,708	218,954	1900	3,694,646	Not available
1883	1,503,259	192,795	....	....	....

PRODUCTION—NOVA SCOTIA AND BY DISTRICTS AND EXPORTS, 1901-1944

Date	Total	Production				Exports
		Cape Breton		Cumberland	Pictou	
		Sydney Coalfield	Other			
1901	4,279,557	3,116,641	40,303	538,773	533,840	767,683
1902	5,292,538	3,886,903	148,539	621,791	635,305	1,170,430
1903	5,841,429	4,073,824	296,110	679,332	792,164	1,175,167
1904	5,747,823	3,973,433	332,146	731,316	710,928	975,124
1905	5,821,622	4,248,970	210,698	693,500	668,454	982,437
1906	6,546,191	4,804,407	312,554	659,734	769,496	Not available
1907	6,468,563	4,698,147	395,836	534,047	840,533	Not available
1908	6,805,489	4,840,653	452,877	662,157	849,802	Not available
1909	5,718,871	4,081,333	398,759	494,919	748,860	400,392
1910	6,515,162	5,035,800	414,153	350,363	714,846	579,837
1911	7,125,551	5,405,355	347,944	538,296	833,956	621,704
1912	7,834,724	6,039,296	312,836	716,914	765,678	675,871
1913	8,135,104	6,313,275	329,108	675,544	817,177	680,224
1914	7,448,042	5,767,560	296,624	702,496	681,356	639,460
1915	7,513,739	5,920,670	275,049	736,794	581,226	867,846
1916	6,911,995	5,317,756	296,111	685,517	612,611	723,645
1917	6,345,335	4,680,650	227,529	711,164	725,992	611,406
1918	5,836,370	4,294,832	234,678	722,139	584,721	529,985
1919	5,804,674	4,144,495	216,790	688,981	754,408	994,107
1920	6,495,237	4,553,845	278,193	779,555	883,644	920,477
1921	5,734,928	4,244,172	186,755	694,398	609,603	790,562
1922	5,569,072	4,069,239	175,181	681,018	643,634	678,245
1923	6,597,838	4,661,373	164,681	862,087	909,697	758,789
1924	5,557,441	4,135,693	88,474	674,806	658,468	356,657
1925	3,842,978	2,568,071	149,668	518,733	606,506	262,299
1926	6,747,477	5,091,664	147,139	715,578	793,096	582,818
1927	7,071,876	5,402,531	129,520	663,407	876,418	584,546
1928	6,743,504	5,070,017	135,866	730,891	806,730	370,119
1929	7,056,133	5,380,652	157,470	795,714	722,297	371,744
1930	6,252,552	5,594,446	155,088	802,266	700,752	374,878

PRODUCTION—NOVA SCOTIA AND BY DISTRICTS AND EXPORTS, 1901-1944—concluded

Date	Total	Production				Exports
		Cape Breton		Cumberland	Pictou	
		Sydney Coalfield	Other			
1931	4,955,563	3,449,472	140,505	694,097	671,489	206,865
1932	4,084,581	2,831,753	120,909	634,516	497,403	158,805
1933	4,557,590	3,444,118	102,628	604,893	405,951	170,521
1934	6,341,625	4,926,085	116,872	738,017	560,651	209,931
1935	5,822,075	4,413,570	116,978	702,496	589,031	292,807
1936	6,649,102	5,158,877	142,540	701,767	645,918	269,983
1937	7,256,954	5,490,819	186,927	807,651	771,557	198,911
1938	6,236,417	4,676,730	173,535	713,768	672,384	188,025
1939	7,051,176	5,413,615	121,374	808,051	708,136	190,087
1940	7,848,921	5,896,839	173,122	929,497	849,463	283,723
1941	7,387,762	5,384,375	152,795	1,064,244	786,348	316,968
1942	7,204,852	5,289,250	120,957	1,123,029	671,616	475,241
1943	6,103,085	4,435,018	96,085	971,206	600,776	466,167
1944	5,745,671	4,225,683	93,400	880,799	545,789	464,556

SOURCE: All figures are from Coal Statistics for Canada with the following exceptions: From 1872 to 1920 production statistics are taken from annual reports of the former Bureau of Mines. Export figures for the years up to 1899 are taken from Trade and Navigation records of the Dominion Government. These figures were not recorded by provinces after 1899. From 1900 to 1920, inclusive, there are no customs figures for coal on a provincial basis, and the figures used are shipments by Nova Scotia operators direct to foreign destinations as shown in Coal Statistics for Canada. These figures do not reflect accurately exports as an appreciable tonnage of Nova Scotia coal is exported through Nova Scotia and New Brunswick ports by persons other than the operators. For the years 1921 to 1944 an estimate of Nova Scotia exports has been made by subtracting from the total exports of Canadian coal from Nova Scotia and New Brunswick ports as recorded by Customs the export shipment recorded by mine operators of the Province of New Brunswick.

There was a steady growth in production in Nova Scotia in the years immediately following Confederation, output approximately doubling between 1867 and 1873 and reaching almost 1,200,000 tons in the latter year. It then fell off during the depression of the 1870's. Prior to Confederation, export markets were of primary importance. With the abrogation of the Reciprocity Treaty in 1866 there was a sharp reduction in exports to the United States, which at that time were taking over 50 per cent of total production. Total exports fell both absolutely and relatively to only 20 per cent of production in 1875 and 10 per cent in 1880. This loss was offset by development of new markets in the St. Lawrence Valley. National fiscal policy from 1879 had considerable influence on Nova Scotia coal mining—directly by coal tariffs and indirectly by development of industries which have consumed a substantial proportion of Nova Scotia production.

In 1880 production again exceeded one million tons and continued a steady growth, almost doubling between 1885 and 1891 and again between 1891 and 1901. The stimulus to coal production from railway building and the development of iron and steel and other coal consuming industries was very important, the greatest development coming with the establishment of a primary steel industry at Sydney in 1901. Exports increased again at the turn of the century, but continued to take only about 10 per cent of the output—a ratio which was maintained until the 1920's.

Production continued to grow until 1913, when it reached its all-time peak of 8,135,000 tons. The end of railway expansion left the iron and steel industry of the Maritime Provinces with the problem of finding other markets, and industry in Canada was tending to concentrate in parts of the country where the use of Nova Scotia coal was not profitable. The St. Lawrence trade, which had grown steadily until the start of the first World War, was moved chiefly by water. Exigencies of the war brought about the loss of most of the vessels used for this movement, and the Quebec market was largely lost. This was counteracted by an increasing local demand due to wartime industrial activity in the steel mills and general industry and increased demands upon the transportation system.

The St. Lawrence market was largely recovered by Nova Scotia following the war, but during the 1920's the steel industry of the Maritime Provinces experienced serious reverses. A series of strikes also tended to keep production down, the most serious being in 1925 when production fell to 3,843,000 tons. There was a further loss of export markets during the 1920's, and exports since that time have rarely taken more than 5 per cent of output. To stimulate Nova Scotia production a system of transportation subventions was developed by the Federal Government which came into full effect by 1931, and the customs tariff was increased the same year. During the depression of the 'thirties production fell off sharply and then recovered somewhat. Over the period from 1913 to 1938, with the exception of the serious strike year of 1925 and the early years of the depression, production held within the comparatively narrow range of 5,500,000 to 7,000,000 tons per annum. Under stimulus of wartime demands it rose again during the early war years to 7,848,000 tons in 1940, falling off to approximately 5,750,000 tons in 1944.

NEW BRUNSWICK

Mining started in New Brunswick about 1825. New Brunswick production did not exceed 1 per cent of the Canadian total until 1916 and was less than 3 per cent at its all-time peak of 547,000 tons reached in 1940. By 1944 it had dropped to 345,000 tons.

The following table shows that coal production in New Brunswick has fluctuated considerably:

Year	Short Tons	Year	Short Tons	Year	Short Tons
1887	10,040	1906	34,076	1925	208,012
1888	5,730	1907	34,584	1926	173,111
1889	5,673	1908	60,000	1927	203,950
1890	7,110	1909	49,029	1928	207,738
1891	5,422	1910	55,455	1929	218,706
1892	6,768	1911	55,781	1930	209,349
1893	6,200	1912	44,780	1931	182,181
1894	6,469	1913	70,311	1932	212,695
1895	9,500	1914	98,049	1933	312,303
1896	7,500	1915	127,391	1934	314,750
1897	6,000	1916	143,540	1935	346,024
1898	6,160	1917	189,095	1936	368,618
1899	10,528	1918	268,212	1937	364,714
1900	10,000	1919	166,377	1938	342,238
1901	17,630	1920	171,610	1939	468,421
1902	18,795	1921	187,192	1940	547,064
1903	16,000	1922	287,513	1941	523,344
1904	9,112	1923	276,617	1942	435,203
1905	29,400	1924	217,121	1943	372,873
				1944	345,123

SOURCE: Coal Statistics for Canada.

Completion in 1905 of a railway connecting the Minto coal field with the Intercolonial assisted the development of the industry. Heavy railway demands during World War I provided a further stimulus to production, which reached a peak of 268,000 tons in 1918. This sharp increase was achieved largely through the introduction of strip mining. Production fluctuated until 1924, when it became stable at about 200,000 tons annually until 1932. From 1933 a steady increase is recorded until 1939. During the early war years a considerable increase was achieved largely through stripping operations.

The market for New Brunswick coal has been limited almost entirely to local uses within the Province, and production has not been greatly affected by changes in tariffs or introduction of transportation subventions.

SASKATCHEWAN

Production in Saskatchewan is concentrated in the Estevan area, with limited output in the Wood Mountain-Willowbunch and in the Cypress Hills districts. The coal produced in Saskatchewan is all lignite.

The record of production in Saskatchewan is as follows:

Year	Short Tons	Year	Short Tons	Year	Short Tons
1892	5,400	1910	181,156	1928	471,713
1893	8,325	1911	206,779	1929	580,189
1894	15,051	1912	225,342	1930	579,424
1895	15,769	1913	212,897	1931	662,836
1896	16,706	1914	232,299	1932	887,139
1897	25,000	1915	240,107	1933	927,649
1898	25,000	1916	281,300	1934	909,288
1899	25,000	1917	355,445	1935	921,785
1900	40,500	1918	346,847	1936	1,020,792
1901	45,000	1919	379,347	1937	1,049,348
1902	70,400	1920	335,222	1938	1,022,166
1903	116,703	1921	335,632	1939	960,000
1904	124,885	1922	382,437	1940	1,097,517
1905	107,596	1923	438,100	1941	1,322,763
1906	108,398	1924	479,118	1942	1,301,116
1907	151,232	1925	471,965	1943	1,665,972
1908	150,556	1926	439,803	1944	1,372,766
1909	192,125	1927	470,216		

SOURCE: Coal Statistics for Canada.

Before 1930 the output of the Saskatchewan mines was used almost entirely for domestic purposes in Saskatchewan and Manitoba, although in the 'twenties the railroads started to take a substantial tonnage for stationary installations. Production in this period was less than 500,000 tons per annum.

About 1930 several factors combined to stimulate production. Stripping operations, which had been carried on for some years in a small way, were undertaken on a large scale by a new operator. In addition, an effective campaign was undertaken to educate potential consumers in the technique of using lignite coals. The depression years aided this campaign by producing a consumer demand for cheaper fuels. Prior to 1930 the main product of the Saskatchewan fields was lump coal for domestic use. At the present time industrial sizes comprise about 70 per cent of the output. In 1943 Saskatchewan production represented almost 10 per cent of the Canadian total.

ALBERTA

Production in Alberta started with railway construction by the Canadian Pacific Railway Company. Development of other coal fields followed railway construction by the Grand Trunk Pacific in 1911 and 1912, and by the Canadian Northern Railway in 1913. The railways provided a market in themselves and afforded transportation facilities to other markets. The development of Alberta production from practically nothing in 1880 to over 4,250,000 tons in 1913 is tied directly to railroad expansion. In the case of the Crowsnest Pass area, development of the metallurgical plants in British Columbia and the United States was an added factor.

Production of coal in Alberta has been as follows:

ALBERTA—PRODUCTION

Date	Short Tons	Date	Short Tons	Date	Short Tons
1886	43,220	1906	1,385,000	1926	6,508,908
1887	74,152	1907	1,834,745	1927	6,936,780
1888	115,124	1908	1,845,000	1928	7,334,179
1889	97,364	1909	2,174,329	1929	7,147,250
1890	128,753	1910	3,036,757	1930	5,755,911
1891	174,131	1911	1,694,564	1931	4,564,290
1892	178,970	1912	3,446,349	1932	4,870,030
1893	230,070	1913	4,306,346	1933	4,714,784
1894	184,940	1914	3,821,739	1934	4,748,848
1895	169,885	1915	3,434,891	1935	5,462,973
1896	209,162	1916	4,638,604	1936	5,696,375
1897	242,163	1917	4,863,414	1937	5,551,682
1898	315,088	1918	6,148,620	1938	5,230,015
1899	309,600	1919	5,022,412	1939	5,518,105
1900	311,450	1920	6,908,923	1940	6,205,088
1901	340,275	1921	5,937,195	1941	6,970,064
1902	402,819	1922	5,976,432	1942	7,754,279
1903	495,893	1923	6,866,923	1943	7,677,982
1904	661,732	1924	5,203,713	1944	7,427,433
1905	931,917	1925	5,883,394		

SOURCE: Figures up to 1906 are from Coal Statistics for Canada. From 1906 to 1944 inclusive they are taken from the annual reports of the Alberta Department of Mines.

The only interruption to the steady growth of production in Alberta up to the start of World War I was in 1911, when a serious strike cut production in half. During the early war years production fell, but later output expanded to surpass 6,000,000 tons in 1918.

Cessation of war demands combined with a strike brought production down in 1919, but the following year a new peak was attained. Output continued to rise substantially throughout the 'twenties. At this time United States anthracite was permanently displaced by western coal in the Manitoba market.

In 1928 production reached a high point of 7,334,000 tons. During the early 'thirties the depression brought a decline although transportation subventions, introduced by the Federal Government in 1931, to promote the eastern movement of Alberta coal, helped minimize its effects. Output rose again to over 7,750,000 tons by 1942. For the past thirty-five years the growth in Canadian production has been primarily the result of increased production in Alberta.

In Alberta coal is usually classified as "steam" or "domestic". The following figures show total production of coal in Alberta according to this classification:

ALBERTA—PRODUCTION BY COALS

Date	"Domestic" Coal	"Steam" Coal	Date	"Domestic" Coal	"Steam" Coal
1906	602,780	782,220	1926	3,160,029	3,348,879
1907	639,335	1,195,410	1927	3,357,171	3,579,609
1908	584,334	1,250,666	1928	3,378,200	3,955,979
1909	763,673	1,410,656	1929	3,385,749	3,761,501
1910	878,011	2,158,746	1930	2,874,090	2,881,821
1911	964,700	729,864	1931	2,246,544	2,317,746
1912	1,341,389	2,104,960	1932	2,576,831	2,293,199
1913	1,763,225	2,543,121	1933	2,434,047	2,280,737
1914	1,697,401	2,124,338	1934	2,295,566	2,453,282
1915	1,682,922	1,751,969	1935	2,647,912	2,815,061
1916	2,172,801	2,475,803	1936	2,841,231	2,866,144
1917	2,537,829	2,325,585	1937	2,631,150	3,137,679
1918	3,035,061	3,113,559	1938	2,453,263	2,776,762
1919	3,611,009	2,411,403	1939	2,449,199	3,068,906
1920	3,359,309	3,549,615	1940	2,537,205	3,667,883
1921	2,943,141	2,994,054	1941	2,713,254	4,256,810
1922	3,086,669	2,889,763	1942	3,213,113	4,541,166
1923	3,161,741	3,705,289	1943	3,416,037	4,261,945
1924	3,096,660	2,107,053	1944	3,146,801	4,280,632
1925	3,156,359	2,727,035			

SOURCE: Annual Report of Alberta Department of Mines.

Development of production of "steam" coal was much more rapid than of "domestic" coal during the period of railway building in Western Canada. During the years of World War I "domestic" production increased until it equalled that of "steam" coal. At the present time "steam" coal comprises about 58 per cent of Alberta production.

Records relating to exports from Alberta are not satisfactory, but following are some figures which will illustrate their limited extent. For most of its production history, exports have taken only 1 per cent or 2 per cent of Alberta's output.

ALBERTA—EXPORTS

Date	Short Tons	Date	Short Tons	Date	Short Tons
1909	114,101	1921	146,200	1933	18,498
1910	243,371	1922	113,165	1934	13,925
1911	40,884	1923	83,705	1935	32,785
1912	93,126	1924	44,678	1936	29,727
1913	139,536	1925	49,757	1937	47,013
1914	105,699	1926	48,012	1938	35,910
1915	25,050	1927	46,042	1939	35,373
1916	60,124	1928	52,976	1940	37,665
1917	90,239	1929	51,247	1941	34,890
1918	132,765	1930	44,235	1942	101,394
1919	121,264	1931	30,629	1943	459,551
1920	132,918	1932	27,030	1944	293,545

SOURCE: Figures for years 1909 to 1920 inclusive are taken from annual reports of the former Bureau of Mines. In later years they are taken from Coal Statistics for Canada.

BRITISH COLUMBIA

Production of coal in British Columbia was confined to Vancouver Island until 1898. Output was insignificant prior to 1850, when coal miners and machinery were brought in from the United Kingdom. With the construction of the Canadian Pacific line through the Crowsnest Pass, mining developed in that area in 1898. In the period 1906 to 1910 a number of mines were opened in south-central British Columbia in areas commonly referred to as the Inland fields.

The following table shows production of coal in long tons for the Province by principal producing fields:

COAL PRODUCTION—BRITISH COLUMBIA

(Long Tons)

Date	Total	Vancouver Island	Crowsnest Pass	Inland
1836-1866	191,437	191,437		
1867	31,239	31,239		
1868	44,005	44,005		
1869	35,802	35,802		
1870	29,843	29,843		
1871 } 1872 } 1873 }	148,459	148,459		
1874	81,061	81,061		
1875	97,644	97,644		
1876	140,184	140,184		
1877	139,692	139,692		
1878	190,848	190,848		
1879	232,390	232,390		
1880	272,362	272,362		
1881	229,514	229,514		
1882	288,572	288,572		
1883	214,955	214,955		
1884	393,866	393,866		
1885	333,024	333,024		
1886	335,192	335,192		
1887	434,055	434,055		
1888	481,667	481,667		
1889	568,249	568,249		
1890	685,345	685,345		
1891	1,009,131	1,009,131		
1892	836,802	836,802		
1893	976,768	976,768		
1894	993,418	993,418		
1895	944,683	944,683		
1896	894,882	894,882		
1897	892,295	892,295		
1898	1,135,865	1,126,531	9,334	
1899	1,306,324	1,203,199	103,125	
1900	1,590,179	1,383,376	206,803	
1901	1,691,557	1,312,202	379,355	
1902	1,641,626	1,173,893	223,501	
1903	1,450,663	860,775	589,888	
1904	1,685,698	1,023,013	662,685	
1905	1,825,832	993,899	831,933	
1906	1,899,076	1,178,627	720,449	
1907	2,219,608	1,332,009	876,731	10,868
1908	2,109,387	1,200,582	883,205	25,600
1909	2,400,600	1,414,375	923,865	62,360
1910	3,139,235	1,616,030	1,365,119	158,086
1911	2,297,718	1,625,122	442,057	230,539
1912	3,025,709	1,558,240	1,261,212	206,257
1913	2,570,760	973,493	1,331,725	265,542
1914	2,166,428	1,072,314	955,183	138,931
1915	1,972,580	1,020,942	852,572	99,066
1916	2,485,580	1,492,761	882,270	110,549
1917	2,398,715	1,695,721	551,751	151,243
1918	2,578,724	1,666,211	732,864	179,649

COAL PRODUCTION—BRITISH COLUMBIA—concluded

(Long Tons)

Date	Total	Vancouver Island	Crowsnest Pass	Inland
1919	2,408,948	1,699,348	558,806	150,794
1920	2,696,774	1,698,254	847,389	151,131
1921	2,569,639	1,625,931	759,755	183,953
1922	2,580,915	1,754,656	554,361	271,898
1923	2,542,987	1,574,663	740,531	227,793
1924	1,987,533	1,486,332	273,518	227,683
1925	2,444,292	1,412,757	854,480	177,055
1926	2,330,036	1,293,175	848,448	188,413
1927	2,453,827	1,331,325	907,519	214,983
1928	2,526,702	1,277,533	1,001,523	247,646
1929	2,251,252	1,120,805	886,706	243,741
1930	1,887,130	988,805	689,236	209,089
1931	1,707,590	831,925	661,426	214,239
1932	1,534,975	749,006	587,875	198,094
1933	1,264,746	613,203	477,677	173,866
1934	1,347,090	574,508	627,619	144,963
1935	1,187,968	630,213	407,110	150,645
1936	1,346,471	713,037	470,606	162,828
1937	1,444,687	818,447	459,136	167,104
1938	1,309,428	684,398	434,068	190,962
1939	1,477,872	717,334	561,958	198,580
1940	1,667,827	732,659	776,518	158,650
1941	1,802,353	647,958	1,026,053	128,337
1942	1,938,158	738,600	1,047,713	151,845
1943	1,821,654	729,989	927,482	164,183
1944	1,933,639	689,714	1,120,665	123,260
1945	1,518,673	557,778	869,647	91,248

SOURCE: Up to 1896 the figures are from Coal Statistics for Canada converted to long tons. From 1896 to 1944 inclusive they are from annual reports of the British Columbia Department of Mines.

It will be noted from the table that production increased more or less steadily until 1910, when an all-time peak of over 3,000,000 long tons was reached. After 1898 the continuing upward trend was due largely to operations in the Crowsnest Pass to supply the growing requirements of railways and metallurgical industries in British Columbia and in the United States. Total production in the Province dropped sharply in 1930, and has not since regained the level attained in the 'twenties. Declining output on Vancouver Island from the mid 'twenties to the mid 'thirties was the dominant feature in this connection. During World War II the Crowsnest Pass area became the major producing field in the Province.

The outstanding influence on British Columbia coal production during the last twenty-five years has been intense competition with alternative fuels—particularly fuel oil. The effect of this competition on export markets is discussed later. Within the Province the most important developments were the growing use of oil-burning locomotives by the railways after 1917 and of oil for ships' bunkerage. The sharp temporary declines in 1911, 1913 and 1924 reflect industrial disputes. The effect of the depression of the 'thirties on production was mitigated to some extent by the introduction of transportation subventions and Federal subsidies on coal delivered for ships' bunkerage or exported other than to the United States.

Export markets have been relatively more important to British Columbia mines than to those of any other part of Canada. Development of Vancouver Island production was in a considerable degree based upon the existence of a large export market in California and other Pacific Coast States; and from time to time exports were made to other Pacific areas, such as Alaska, Chile, the

Hawaiian Islands and Japan. The development of the Crowsnest Pass area was stimulated by the demands of railways and metallurgical industries in the United States.

The export position of British Columbia mines cannot be fully appreciated unless particular reference is made to coke as well as to coal. A substantial proportion of the production from the Crowsnest Pass area was used by the collieries for the manufacture of coke, which was in large part exported. In the earlier years there was some coke production at the Vancouver Island mines, but as soon as the Crowsnest Pass mines came into operation Vancouver Island production of coke fell off and disappeared entirely in 1910. There was some coke production in Vancouver Island during World War I, but production ceased again in 1919.

The following table shows exports of coal for the Province of British Columbia by the principal producing fields, coal used in coke production, coke produced, and coke exported.

COAL EXPORTS, COAL USED IN COKE PRODUCTION COKE PRODUCED AND COKE EXPORTED

(Long tons)

Date	Coal Exports				Coal Used in Coke Production	Coke	
	Total	Vancouver Island	Crowsnest Pass	Inland		Production	Exports
1874	56,038	56,038					
1875	66,392	66,392					
1876	122,329	122,329					
1877	115,381	115,381					
1878	164,682	164,682					
1879	192,096	192,096					
1880	225,849	225,849					
1881	189,323	189,323					
1882	232,411	232,411					
1883	149,567	149,567					
1884	306,478	306,478					
1885	237,797	237,797					
1886	249,205	249,205					
1887	334,839	334,839					
1888	365,714	365,714					
1889	443,675	443,675					
1890	508,270	508,270					
1891	806,479	806,479					
1892	640,579	640,579					
1893	768,917	768,917					
1894	827,642	827,642					
1895	756,334	756,334					
1896	634,238	634,238	...	...	...	1,240	...
1897	619,860	619,860	...	...	...	17,831	2,573
1898	752,863	752,863	...	...	...	35,361	3,205
1899	751,711	751 711	...	...	...	34,251	9,000
1900	914,184	906,215	7,968	...	150,584	85,149	51,757
1901	914,163	841,300	72,863	...	231,226	127,081	47,379
1902	776,809	675,033	101,776	...	244,232	128,015	38,780
1903	549,448	403,438	146,010	...	282,469	165,543	27,758
1904	533,593	415,405	118,188	...	432,070	238,428	100,281
1905	673,700	427,698	246,002	...	441,520	271,785	117,637
1906	679,829	448,966	230,863	...	381,773	199,227	61,704
1907	673,114	381,704	291,410	...	419,541	222,913	60,110
1908	597,157	330,328	266,829	...	431,538	247,399	37,314
1909	741,646	388,217	353,389	40	394,124	258,703	40,478
1910	1,175,099	420,442	751,087	3,570	339,189	218,029	8,730
1911	612,696	400,893	209,894	1,909	104,656	66,005	1,267
1912	967,138	411,830	551,742	3,566	396,905	264,333	50,257
1913	627,515	96,327	527,620	3,568	433,277	286,045	50,626
1914	602,707	210,719	389,383	2,605	355,461	234,577	54,313
1915	658,976	284,230	370,020	4,726	361,451	245,871	24,597
1916	844,045	451,408	386,953	5,684	401,487	267,725	34,377
1917	792,779	553,119	225,847	13,813	248,740	159,905	12,711
1918	811,238	457,048	342,218	11,972	276,479	188,967	17,404
1919	763,990	385,927	373,348	4,715	141,407	91,138	8,134

COAL EXPORTS, COAL USED IN COKE PRODUCTION, COKE PRODUCED AND COKE EXPORTED—concluded

(Long Tons)

Date	Coal Exports				Coal Used in Coke Production	Coke	
	Total	Vancouver Island	Crowsnest Pass	Inland		Production	Exports
1920	799,940	316,432	479,342	41,166	101,649	67,792	31,718
1921	815,441	291,513	495,331	28,597	85,644	59,434	18,092
1922	762,118	356,088	333,451	72,579	69,072	45,835	15,524
1923	556,632	156,463	353,725	46,454	89,764	58,919	23,564
1924	209,686	118,554	70,674	20,458	48,007	30,615	8,232
1925	391,883	141,623	249,436	824	115,770	75,185	21,936
1926	293,925	96,409	197,233	283	142,838	93,448	26,296
1927	377,564	105,035	271,995	534	129,933	85,072	21,919
1928	332,445	89,516	240,023	2,906	92,607	61,370	13,902
1929	322,481	89,187	232,217	1,077	103,109	67,280	Not available
1930	143,211	65,279	76,752	1,180	98,174	65,810	22,672
1931	81,007	37,774	43,023	210	98,411	65,410	16,672
1932	59,702	31,757	27,665	280	42,536	29,545	12,855
1933	38,345	19,686	18,588	71	8,435	5,444	4,455
1934	45,535	22,003	23,532	....	47,894	22,182	6,609
1935	54,195	31,104	23,091	....	37,178	24,170	15,563
1936	75,435	36,870	38,565	....	11,534	30,370	14,686
1937	89,220	46,199	43,018	3	67,634	43,215	24,079
1938	91,445	44,045	47,400	....	77,335	48,760	23,531
1939	98,705	40,885	57,820	....	78,228	51,205	21,970
1940	154,287	79,597	74,690	....	88,418	59,788	21,575
1941	122,687	38,055	84,632	....	125,792	83,954	29,737
1942	190,994	64,414	126,580	....	128,441	85,555	31,224
1943	178,696	24,457	154,239	....	116,485	77,355	35,338
1944	210,440	54,197	156,225	18	113,056	75,317	35,334
1945	144,691	32,763	111,928	....	89,821	64,774	28,012

Source: Up to 1896 the figures are from Coal Statistics for Canada converted to long tons. From 1896 to 1944, inclusive, they are from annual reports of the British Columbia Department of Mines.

Production in the Province until the turn of the century was based largely on the export market. From about 1890 to 1923 coal exports were fairly stable at approximately 750,000 long tons annually. In the same period annual production increased three-fold, with the result that exports fell from a maximum of 85 per cent of output to about 30 per cent. This decline in importance of the export market is slightly reduced if account is taken of the coal used in the manufacture of exported coke. In 1924 exports declined sharply to some 300,000 long tons annually, with a further severe reduction to some 50,000 long tons annually in the 'thirties. By 1944 exports had risen to over 200,000 long tons.

Vancouver Island exports show a distinct decline from 1900 to 1930, from which time they have ranged from 22,000 to 80,000 long tons annually. The principal factor in this decline was oil competition, particularly following the discovery of new oilfields in California in 1921. Crowsnest Pass exports grew rapidly after 1900, but fell slowly in the early 1920's and sharply at the end of the decade as the Great Northern Railway converted to oil.

YUKON AND NORTHWEST TERRITORIES

There is little to be said regarding the coal mining in the Yukon and Northwest Territories. Production has been limited to a few hundred tons annually for local use.

CHAPTER III

MINING METHODS

The purpose of this chapter is to review the mining methods in use in Canadian coal mines and the experience of the mines in terms of productivity. Productivity is used here to mean the average number of tons of coal produced per day per man employed, or tons per man-day. The financial records of the mines are reviewed elsewhere in the report. An impression of the location and dimensions of the Canadian coal mining industry can be gathered from the following tabulation relating to 1944.

—	No. of Operators	Capital Invested (millions of dollars) 1943	Production (thousands of net tons)	Employment (Wage Earners)	Productivity (Tons per Man-Day)
Nova Scotia	19	46.7	5,746	12,099	1.65
New Brunswick	19	1.4	345	870	1.47
Saskatchewan	89	3.7	1,373	601	8.66
Alberta	196	37.5	7,429	7,665	3.67
British Columbia	26	22.7	2,134	2,650	2.92
Canada	349	111.9	17,027	23,885	2.57

SOURCE: Dominion Bureau of Statistics.

Before reviewing the operations of the mines, it may be helpful to indicate in broad general terms the alternative systems of coal mining and recent trends in mining techniques. It will be realized that coal mining is a highly technical subject and the summary remarks on mining methods are designed only to introduce the reader to the more detailed remarks which appear in the review of the Canadian mines. Again, only the broad principles of the various methods are described. In actual practice many variants of these methods have been developed to meet local conditions.

SYSTEMS OF MINING

A basic distinction in coal mining methods is between underground mining, the traditional method, and strip or open-cut mining in which the coal is dug from an open pit or quarry.

STRIP MINING

In recent years there has been an increased adoption of strip mining. This has developed largely as the result of improvements in earth-moving machinery. With the use of heavy machinery it has become economically feasible to recover coal from open-cut operations at increasingly great depth. Some particulars of the amount of coal mined in this way in Canada in 1945 are as follows:

—	Class of Coal	Net Tons	Percentage of Total Production
New Brunswick	Bituminous	138,792	38
Saskatchewan	Lignite	1,110,340	72
Alberta	Bituminous	473,771	10
	Sub-bituminous	827,820	26
	Total Alberta	1,301,591	17
Canada	Bituminous	612,563	5
	Sub-bituminous	827,820	26
	Lignite	1,110,340	72
	Total Canada	2,550,723	15

High productivity is commonly achieved in strip mining. The highest output per man-day among the Canadian mines is achieved in Saskatchewan in open-cut operations, where the output per man-day is up to 14 tons. Strip mining, however, is necessarily confined to the relatively few areas where the ratio of the overburden to the recoverable coal is low.

Underground Mining

There are two main systems of underground mining aside from underground gasification of coal, the application of which has been limited to the U.S.S.R. These two systems, known as room-and-pillar mining and longwall mining, are both used in Canada. In either system the initial approach to the coal from the surface is either by vertical shaft, by drift, or by slope. Where the coal lies either level with or above the point of entry, the entrance is referred to as a drift. Where the entrance has a downward gradient it is referred to as a slope. From these mine entrances a system of roadways is developed, designed to provide continual access to the coal beds and efficient transportation of men, materials and coal. The roadways are variously referred to as main entries, levels, entries, and cross-entries. The main entries and levels might be likened to the trunk highways, the entries and cross-entries to the secondary roads of the underground transportation system. These roadways are also used as air passages for ventilation. Their pattern will depend on physical conditions and the general plan of the mine.

Room-and-Pillar System

In this system the coal to be worked is divided into blocks by driving entries and cross-entries. Each block is then mined by cutting further entries or "rooms" angling off the cross-entries, coal being left standing between the rooms to support the roof, the strata immediately above the coal seam. The remaining coal, or the pillars, is often recovered in subsequent operations. The width of the rooms, the distances between them, and the thickness of the pillars depend on the character of the roof and floor, the thickness of the seam and the nature and amount of cover (the overburden of rock and earth between the coal and the surface). Generally, larger pillars are required as the depth of mining increases. Rooms are usually from 200 to 400 feet long. Where possible, they are driven to the rise of the coal seam in order to take advantage of gravity for haulage purposes and also to avoid the accumulation of water at the working face, the point at which the coal is actually mined.

Normally a substantial proportion of pillar coal is recovered after most or all of the rooms in the block of coal have been driven to their full length. This "drawing" of the pillars is done usually by a series of cross-cuts driven through the pillar at right angles to the length of the room, the roof of each cross-cut being allowed to cave in after the cut is completed, and a "fender" of coal from two to six feet wide being left standing between each cross-cut. The drawing of each pillar is done according to a program for the whole coal block which is intended to control the "fracture line", or line of caving of the roof. Unless the pillars can be recovered, room-and-pillar mining is wasteful of coal resources. The removal of pillars is generally commenced soon after the completion of the rooms in the block, as with time the pressure of the roof on the pillars tends to increase, with consequent crushing and loss of the pillar coal. The degree of extraction is determined more by economic factors than by physical problems of extraction. Where coals have a high market value and reserves are limited, there will be a high degree of extraction, and where reserves are plentiful and market value is relatively low, some recoverable coal will be left in the pillars if mining regulations permit. For instance, the principal demand on the Drumheller mines is for lump size coal, on which there is a very considerable price premium as compared to prices for the very small sizes. Pillars yield a low proportion of lump coal, so only partial recovery is practical.

A modification of the room-and-pillar system, known as the panel system, is often used in large scale operations. At times it is necessary to seal off sections of the mine to prevent spreading of fires or movements of the roof or floor. In the panel system the areas of the coal which are blocked out for working are surrounded on all sides by barrier walls of solid coal. Throughout the development of entries and roofs and the drawing of the pillars these barriers remain intact except for a minimum number of passages required for haulage and ventilation. In the event of fire the few openings into the panel can be quickly sealed and its influence thereby restricted to a relatively small portion of the mine. Similarly, in the event of a "squeeze" of the roof or floor the strength of the barrier walls or pillars will confine the pressure within the panel.

Longwall System

The distinguishing feature of the longwall system of mining is that the coal is extracted in a single operation, the working face advancing in an unbroken line or wall. The roof is allowed to cave behind the working face, protection being given to the miners working at the face by means of various forms of temporary roof support at the face. The mined-out areas are referred to as the waste or gob. As regards levels and main entries the plan of the mine does not necessarily differ substantially from that of a room-and-pillar mine, although the entries and cross-entries are often driven diagonally instead of on the square to reduce haulage distances.

There are two alternative methods of procedure in longwall mining, namely, longwall advancing and longwall retreating. In longwall advancing the working face starts from the end of the coal block nearest to the mine entrance and advances inward. In longwall retreating narrow entries are driven through the coal to the far boundary and the working face starts at that point, the coal being completely mined as the face is brought back to the point from which the entries were driven. In longwall advancing the waste material is built up in the form of pack-walls as roof support along the side of the roadways. Longwall advancing is sometimes preferred because it provides for early production of coal and thus a quick return on capital invested, and there is some saving in immediate costs through the elimination of the expense of driving and maintaining extended roadways. On the other hand, longwall retreating in some instances has been found to reduce the cost of maintenance of haulage roads as these are abandoned as the coal is removed. The retreating system also tends to facilitate ventilation.

The panel system is often introduced as a modification of the longwall system for the same reasons as in room-and-pillar operations. Another modification known as shortwall mining differs from longwall only in that the working face is shorter.

Longwall mining is widespread in the United Kingdom and in Canada, but the room-and-pillar system is almost invariably practised in the United States. In Canada the longwall system is used for about half the tonnage produced in Nova Scotia, and in some mines in western Canada, but the room-and-pillar system is used in the great majority of mines of western Canada.

The choice between longwall and room-and-pillar mining systems is not a matter of simple rules. The system adopted will usually be the one calculated to achieve the highest possible productivity at the lowest possible cost per ton, consistent with the safety of the workers and recovery of the coal in marketable condition. A great many factors enter into determining which method is superior in any given situation; some of these factors are outlined below.

1. *Roof and Floor*

Roof control is one of the most important factors in underground mining. In general a roof which is sufficiently strong to stand without extensive support in immediate working areas but which will gradually settle after the coal is extracted is desirable. This facilitates a high degree of extraction and the use of mobile machinery. A weak roof requires extensive timbering which, in addition to increasing mining costs, hinders the use of machinery. On the other hand, an excessively strong roof may lead to the accumulation of stresses and the occurrence of "bumps" when these are suddenly released. The phenomenon of bumps is discussed in later pages. The character of the floor is also important. A soft floor often necessitates large pillars and narrow entries in order to withstand the pressure exerted on it through the pillars, and is a handicap in the use of mobile machinery as it is easily disturbed and is thus loaded with the coal. Certain clays which sometimes form the floor expand when soaked with water from seepage in the mine and the consequent swelling may disrupt haulage and other operations.

2. *The Coal*

Thin seams and limited reserves make total extraction important, and mining methods must be directed to this end. Soft friable coal requires larger pillars than a hard compact coal. The pitch and the thickness of the seam also affect the size of the pillars required, haulage, drainage and other working methods.

3. *Gas*

Gases (mainly methane) generally occur in the seam or in the surrounding strata. In many mines these are an operational hazard because in certain circumstances they are explosive. In these circumstances mining methods have to be directed to providing ventilation adequate to safeguard the workers and to permit if possible the use of machinery.

4. *Market*

If the coal is to be coked, preference is given to the mining method which results in the largest possible proportion of slack. If lump coal commands a premium in the market served, that system is preferable which results in the maximum production of large-sized coal. Continuity of demand influences the mining methods used because any temporary closing down through lack of demand may result in the ruin of the working face through the development of roof pressure. In view of the length of the face involved in longwall mining, a fluctuating market would normally suggest the selection of the room-and-pillar system.

5. *Labour*

Any stoppage of work through labour disputes affects longwall mining operations more seriously than room-and-pillar, due to the deterioration of working faces when left standing. Efficient longwall mining is dependent on the team work of much larger groups of men than is room-and-pillar mining. Absenteeism, therefore, or any other instability in the working force available is a deterrent to longwall mining.

It is not desirable at this point to discuss in any detail the relative advantages of the various systems of mining previously referred to. As might be expected, the subject is highly controversial, and the relative advantage of either system in any given locality naturally leads to broad generalizations which cannot be substantiated. It is interesting, however, to note that a highly competent group of British engineers reporting as a Technical Advisory Committee for the United Kingdom Ministry of Fuel and Power[1] on the mining practices followed in Great Britain gave preference to the room-and-pillar system with longwall retreating and longwall advancing as second and third choices. After full consideration, the British engineers determined that the room-and-pillar system, where it could be operated, resulted in greater productivity per man-shift. Where the room-and-pillar system could not be applied, notably where lower seams had been extracted and where reserves were limited and the seams thin, longwall retreating was favoured as against the advancing system, as the advent of new machinery had largely overcome the previous objection to the retreating system by providing for economic driving of entries at speed. In their opinion, it is possible for the longwall retreating system to secure some of the advantages of both the room-and-pillar and the longwall advancing systems; namely, the free exploration and small amount of dead work from room-and-pillar and the full extraction and continuous faces from longwall advancing. In their report, the Advisory Committee summarized the relative advantages and disadvantages of the room-and-pillar system as compared with longwall advancing as follows:

Advantages of room-and-pillar system:

(i) All roadways in the seam are supported by solid coal for as long as they are required, instead of being formed and maintained in the goaf (gob). This results in better and less costly roads.

(ii) Unproductive labour is reduced by the elimination of the packing of the goaf. In thick seams no ripping at all may be necessary, and in the thinner seams less is required than in unsettled ground. Moreover the roadways seldom need subsequent enlargement.

(iii) The proportion of "productive workers" engaged in actual coalgetting operations is increased and, as unproductive labour is reduced to a minimum, a double advantage is secured and a high OMS (Output per man shift) achieved.

(iv) The system is not dependent upon the completion of specific operations by the end of each shift, and the same operations are continued from one working shift to the next.

(v) As there are none of the difficulties associated with the rigid cycle of operations inherent in longwall mining with coalcutters and conveyers, the advantages of multiple-shift getting can be gained.

(vi) As in the case of longwall retreating, the area to be immediately worked is proved, and initial planning may be modified to deal with faults and intrusions without serious loss of output.

(vii) There is evidence that the workers are attracted by the greater variety of the work, and the greater skill required in its performance, once they have become accustomed to the new technique; and the small size of the groups encourages a team spirit.

(viii) The men are grouped in small teams, each of which is engaged on the same series of operations. Supervision and the maintenance of discipline are, therefore, facilitated, and the standard and progress of the work can be readily checked shift by shift.

[1] See Report of Technical Advisory Committee on Coal Mining, March, 1945, Cmd. 6610.

Disadvantages of room-and-pillar system:

(i) The capital expenditure per ton of output is relatively high.

(ii) The percentage of extraction is usually less than in longwall mining in similar conditions.

(iii) The need for the constant flitting (transference) of machinery from place to place.

(iv) In seams not previously worked by the system, variations in natural conditions make it difficult to be sure that the two successive phases of narrow work and pillar extraction can both be successfully carried through, especially where other seams have been extracted in the same working area.

(v) The use of a large amount of machinery to the best advantage requires a higher standard of planning and organization, and a larger staff of skilled technicians, than are necessary with other intensive systems of mining.

(vi) Subsidence in relation to the surface and other seams cannot be controlled so effectively as in longwall mining.

Mining Techniques

The first method of removing coal from the seam was by pick and shovel. Later, explosives began to be used to break down the coal at the face, the charges being placed in holes bored in the coal with a hand auger. Then tools powered by compressed air were developed for making cuts under, above, or vertically in the coal to improve the effect of explosives, for drilling the shot holes, and for breaking the coal down where, because of gas, explosives could not be used. Most modern equipment is manufactured to use electricity. This applies also to the mechanical loading devices which are now increasingly used in modern mines when conditions permit. Some of these machines almost entirely eliminate the use of the hand shovel. They include mobile and trackmounted loaders and self-loading conveyers, or duckbills, and scrapers. Machines which cut and load are now being introduced.

There are normally four main operations involved in getting the coal from the seam to the haulage system—cutting, drilling, shooting and loading. Unless the coal is soft and breaks easily from the seam, it is undercut either by hand-pick or by machine, sometimes as deep as 8 feet. It may also be cut across the top of the seam and cut vertically or sheared, the latter practice being followed particularly where lump sizes of coal are required. A variety of machines is available which will cut at any level of the coal and either horizontally or vertically. After the cutting operation, holes are drilled at spaced intervals either by hand augers or by power drills. The shot holes are then charged with explosives which are fired either electrically or by fuses according to local mining regulations and safety considerations. In some mines, particularly bituminous mines in Alberta and British Columbia, the use of explosives is prohibited entirely because of the gas hazard. In such mines pneumatic picks or jackhammers are commonly used to break down the coal. When broken down, the coal is loaded by hand shovel (hand loading) or by any of a variety of mechanical devices into mine cars, conveyers, or, in some mines in the mountains, into gravity chutes. These four main operations are carried out as a cycle in the order described. In room-and-pillar mining they may be carried out or repeated in a single shift. Where machinery is used, normal practice is to carry on the operations in a number of rooms in sequence, so that the machinery involved can move from one room to another without delay. In longwall mining the cycle is normally completed in two or three shifts, one loading the coal and the remainder cutting, drilling and shooting the coal, moving tracks or conveyers, timbering and generally preparing for the loading shift.

The transportation of the coal from the face to the surface may be divided into three categories: main, secondary, and gathering haulage. In small collieries these may be consolidated to some extent, but broadly speaking the three stages are the transportation of the coal from the face to the nearest point where mine cars are gathered, from these points in the entries to the principal roadways where large trains may be assembled, and thence to the tipple at the surface. An important recent trend has been increasing capacity of mine cars: two-ton cars were considered large a few years ago, but in the United States bituminous fields four to six-ton cars are now common. Recently developed drop-bottom mine cars automatically dump their loads at the desired point at the surface, and the train or "trip" is turned back into the mine almost without stopping. A further innovation has been the use of shuttle cars for gathering. These shuttle cars are rubber-tired self-unloading electric trucks, which operate in conjunction with power loaders and form a shuttle system between the face and either the secondary or main haulage. Their chief advantage is flexibility but their use is restricted to fairly thick seams and to gradients of not more than one in eight. The productivity of a loading machine served by shuttle cars is reported to be about twice that of the same loader under other circumstances.

COAL PREPARATION

When coal is brought to the surface from either underground or stripping operations it is commonly "prepared" before being moved to market. Preparation, or beneficiation, may be confined to separation into different sizes and the removal by hand of conspicuous impurities which have been loaded with the coal; processes which are referred to as screening, or sizing, and hand-picking. In some instances screening may include crushing to secure the requisite quantity of smaller sizes. In recent years preparation has increasingly included the reduction of the ash, sulphur and other impurities in the coal by mechanical cleaning. In the case of coal sold for domestic use, preparation may also include spraying the cleaned coal with oil or other materials to make the coal dustless. Cleaning may be accomplished by wet washing or by dry cleaning or by a combination of both methods, the dry cleaning method usually being applied to the smaller sizes as these retain more moisture from washing, and drying is normally an expensive operation.

There is a wide variety of cleaning processes, generally based on specific gravity. The specific gravity of coal varies with its ash and moisture content, but normally its specific gravity is lower than that of the impurities. Cleaning methods commonly seek to separate the coal from its impurities by taking advantage of this difference. In wet washing the coal is immersed in water to which chemicals or other materials have been added to increase its specific gravity to a pre-determined figure in order to allow the coal to float while the heavier impurities sink. In Europe a flotation process is used extensively for coal cleaning. This process operates on the principle that the surfaces of coal are wetted less readily by water than are the surfaces of the impurities. There are a number of variants in the flotation method. It is generally held to be an expensive, although more selective, process. Dry cleaning is based on the principle of specific gravity with air currents replacing water. Air currents rising through perforations in reciprocating screens create a condition in which the coal particles are buoyed up by the air currents while the heavier impurities pass through the screens. In the air-sand process, a bed of dry sand is kept fluid by a continuous upward flow of air thus simulating a dense liquid in which the coal flows and the impurities sink.

Coal preparation has been of increasing importance in recent years for two main reasons. In the first place, increasing competition between coal and other fuels has forced operators to improve the quality of their product. In the second place, the increased use of loading machines in the mines has increased the impurity of the coal as brought to the surface. These machines are less selective and extraneous materials such as sandstone, shale and clay from the roof and floor and possibly partings in the seam are loaded with the coal. Improved preparation, therefore, is practically essential with fully mechanized mining.

It should be emphasized at this point that the impurities with which coal is associated as it comes from the mine are removable only to the extent that they are physically detached from the coal. Finely divided impurities disseminated through the coal substance itself remain largely unaffected by ordinary preparation. The shale, clay, sandstone and bone, which usually form the roof and floor of the coal seam and possibly occur as partings in the seam, and which may become mixed with the coal in mining, frequently constitute the major ash-forming components in coal and can be readily removed in the cleaning process. Pyrite, one of the principal sources of sulphur in coal, and phosphorus are also removable if present as discrete particles.

It is difficult to generalize on the necessity of coal preparation. In each instance, the operator has to weigh the return which he will receive against the additional expense of preparing his coal. The economics of coal preparation are determined by the extent to which the impurity of any particular coal can be reduced and subsequent savings in handling charges and higher market returns secured; the cost of the actual operation including the loss of combustible material during the process; and the pressure of competing fuels including other coals.

PRODUCTIVITY

These recent improvements in face loading and transportation have led to a remarkable increase in productivity where they have been applied. Their implications regarding the selection of mining methods are reviewed in some detail in subsequent discussion of production problems in the Sydney coal field in Nova Scotia. The effects of machine loading and improved haulage systems are most apparent in the high productivity achieved in the United States mines where mechanization is most widespread. Statistics are not available to show the exact effect of improved haulages but the following tabulation for underground bituminous mines in some of the States clearly demonstrates an increase in productivity arising out of machine loading:

TONS PER MAN-DAY, UNDERGROUND MINES, 1944

—	With 90 Per cent or More of Output Mechanically Loaded	With Less than 90 Per cent of Output Mechanically Loaded	With 100 Per cent of Output Loaded by Hand	Total
West Virginia	6.68	5.06	4.44	5.32
Kentucky	7.16	4.28	4.47	4.79
Pennsylvania	5.85	4.62	4.27	4.75
Ohio	6.10	4.55	4.08	5.23
Total U.S. underground bituminous mines	6.60	4.56	4.15	5.04

Of a total United States underground bituminous production of 519,000,000 tons in 1944, about 364,000,000 came from these four States. Of this, 208,000,000 tons came from mines with 90 per cent or more of output mechanically loaded, 158,000,000 from mines with some but less than 90 per cent of output mechanically loaded, and 153,000,000 from mines with all output loaded by hand.

It may be said in general that Canada lags far behind the United States in the extent of mechanization of coal mining. Although power tools are widely used in Canada for undercutting and drilling the coal, the proportion of Canadian coal which is loaded by machinery is very small, and little has been done in Canada to match United States improvements in the capacity and speed of haulage systems. Historically, productivity in the United States bituminous coal fields has been substantially higher than in Canadian fields, and in recent years this margin has been increased considerably. This difference between the United States and Canadian trends in productivity, illustrated in the following table, has resulted in a deterioration of the already difficult competitive position of many Canadian coals in Canadian markets reached by United States coals.

TONS PER MAN-DAY, ALL WAGE EARNERS

Some Canadian Coal Fields

—	1934	1939	1944
Cape Breton, N.S.	2.54	2.60	1.73
New Brunswick	1.33	1.42	1.47
Saskatchewan	5.12	5.85	8.66
Drumheller, Alta.	3.73	3.94	3.58
Coalspur, Alta.	4.44	4.49	4.00
Mountain Park, Alta.	3.75	3.71	3.87
Cascade, Alta.	3.09	3.21	4.34
Crowsnest, Alta.	3.07	3.84	3.67
Crowsnest, B.C.	3.97	4.38	4.23
Vancouver Island, B.C.	1.82	1.84	2.03

STATES PRODUCING BITUMINOUS COAL
WHICH COMPETES IN CANADIAN MARKETS

—	1934	1939	1944
West Virginia	4.73	5.51	5.61
Kentucky	4.33	4.68	5.08
Pennsylvania	3.98	4.77	5.28
Ohio	4.23	5.35	6.77

It should be noted that the United States mines which ship to the Canadian market usually achieve a higher productivity than the average for the States in which they operate. In practice, therefore, the above comparison is an understatement.

It is generally recognized that physical conditions in the United States, notably in the central coal field where mechanization has been most widely adopted, are very favourable. Moreover the machinery has been developed to suit these conditions and is not readily adaptable to other conditions; it is more costly to the Canadian operators owing to customs duties. In the review of the Canadian mines which follows, the extent to which mechanized mining can be extended is discussed.

NOVA SCOTIA

Nova Scotia mines produced 5,745,671 tons of coal in 1944 as compared with 7,256,954 tons in 1937. Approximately 87 per cent of this total was produced by subsidiary companies of the Dominion Steel and Coal Corporation, Limited (Dosco), the remaining tonnage being the output of some 10 small independent companies, most of whom are members of the Independent Coal Operators' Association of Nova Scotia. Coal mining in Nova Scotia is almost entirely confined to underground mining, a large percentage of the tonnage coming from submarine operations. Of the 1944 tonnage, 4,319,083 tons were produced on Cape Breton Island. The remainder was produced on the mainland, 880,799 tons coming from the Cumberland coal fields and 545,789 from the Pictou coal field.

Cape Breton Island

Coal production in Cape Breton Island is concentrated in the Sydney coal field. A number of small mines, the principal of which are owned by the Provincial Government at Inverness, operate on the west coast. These account for only 93,400 tons out of the total of 4,319,083 tons produced on the island in 1944. Two large operating companies, the Dominion Coal Company Limited and Old Sydney Collieries Limited, subsidiaries of Dosco, account for over 90 per cent of the total production in the Sydney coal field. The remainder is produced by three small independent operations, which in 1944 produced in aggregate 181,793 tons. The production of the various companies in the Sydney coal field in 1944 was as follows:

Dominion Coal Company Limited	3,361,043
Old Sydney Collieries Limited	682,847
Bras d'Or Coal Company Limited	136,972
Indian Cove Coal Company Limited	31,375
Sullivan Coal Company Limited	13,446

The location of the various mines in the Sydney coal field is indicated on Map 4 appearing in the chapter on Coal Reserves. It will be noted that eight of these collieries are located in the Glace Bay district, three in the New Waterford district, and seven in the Sydney Mines district, north of Sydney Harbour. These mines work six of the twelve coal seams in the Sydney coal field—namely, in descending order, the Harbour, Bouthillier, Phalen, Indian Cove, Emery and Gardner seams. The land areas in the Harbour, Phalen and Emery seams have been largely worked out. A large proportion of the production comes from the Harbour and Phalen seams, which range in average thickness from 5 to 6 and 5.5 to 7.5 feet respectively. The other seams are not as thick or as consistent.

All of the seams dip to the northeast under the sea at about 16 per cent, although gradients as high as 38 per cent are encountered in the workings on anticlinal limbs of the four basins into which folding has divided the field. The strata intervals between them are consistent and sufficient to allow for separate mining of the seams or ultimate connection with other seams by horizontal cross-measure tunnelling. Generally the roof is a weak shale but local areas of sandstone roof occur. The floor varies from a soft fire-clay to hard shale. The coal is of high volatile "A" bituminous rank, and the mines are generally gassy. There is a considerable variation in the quality of coal between seams and areas. The coal has a moderately low ash content and medium to high sulphur content. Calorific values on an as-received basis range from 11,800 to 14,200 B.t.u./lb. The fusion point of ash of the coal is low.

Systematic mining was first undertaken in this field in 1825, although some extraction of coal from outcrops along the coast had been carried on from the time of the earliest settlements. Two of the mines presently operating were opened about seventy-five years ago and a number of the mines are now nearly 50 years old. A number of the hoisting slopes and shafts put down at that time are still in service. The first organized mining efforts were confined to the land area, but over forty years ago the workings penetrated into submarine territory. At the present time nearly 90 per cent of the Dominion Coal Company output and 100 per cent of Old Sydney Collieries production comes from submarine operations. The independent companies largely confine their operations to land areas.

Dosco Companies

The Dominion Coal Company operates eleven mines, eight of which are in the Glace Bay district and three in the New Waterford district. Three of those in the Glace Bay district and one in the New Waterford district are slope mines, the remaining five mines in the Glace Bay district are served by three shafts;

in two instances horizontal cross-measure tunnels having been driven from original workings on the Phalen seam to provide convenient access to the overlying Harbour seam. The workings of these mines are confined to the Harbour, Phalen, Emery and Gardner seams, the largest percentage of production coming from the Harbour and Phalen seams. Old Sydney Collieries operates two mines in the Sydney Mines district. Princess mine, which produces 60 per cent of the company's production, is a shaft mine, whereas Florence colliery is a slope mine. Both collieries work the Harbour seam in the submarine area. Within recent months a strip mine, which will produce 500 tons per day, was opened by that company on the Lloyd Cove seam.

Until about twenty years ago the room-and-pillar system of mining was universally used throughout in these mines but about 1926 physical conditions became so severe in some working sections that it was impossible to win the pillar coal. Accordingly, the longwall system was introduced, the present methods being evolved after a great deal of experimentation and the development of trained crews. At the present time both mines of Old Sydney Collieries operate on the longwall system. The Dominion Coal Company secures 60 per cent of its output from room-and-pillar operations, the remainder coming from longwall mining. Some of the mines use both methods.

In the room-and-pillar system, as carried on in these mines, rooms are usually driven on the strike of the seam. In a number of instances, however, rooms are driven on a slightly rising grade to facilitate haulage. The coal is generally undercut by air-driven radialax machines and bored by air-driven jackhammers. In two cases, however, where the mines are damp, the coal is undercut by electrically-driven shortwall coal cutters. In all cases, coal is loaded by hand into mine cars placed directly at the working face. In many instances in the submarine areas the pillars formed by the driving of the rooms are not drawn but are left in place to support the roof and prevent the infiltration of water from the sea. Where the work is carried on below 800 feet of solid cover pillars are drawn and where physical conditions will permit complete extraction is achieved.

The longwall operations as carried on in these mines are nearly all longwall advancing. Longwall retreating methods were experimented with exhaustively at an earlier date, and it was definitely established that with little exception longwall advancing methods were more economical under the physical conditions of the Sydney coal field. In particular, the weak nature of the roof and pavement necessitated extensive maintenance of the roads developed in the solid. In longwall operations, as practised in the field, faces from 250 to 500 feet in length are developed. They are usually advanced on the strike. In the most recent workings several walls are advanced together, so that they form an uninterrupted face line extending for a length of as much as 1,600 feet. This has the advantage of reducing the cost of roadway construction and maintenance. The faces are protected by 12-foot wide stone mid-walls built on 50-foot centres, and the immediate face is supported by hardwood chocks built close to the face. These chocks are drawn as the walls advance, permitting the gob between the mid-walls to cave. Roadways are protected by stone packs, generally 17 feet in width, and in some cases a double packing system has been used. The coal on the faces is undercut by compressed-air-driven longwall machines to a depth of either 4.5 or 6 feet. Drilling is done by compressed-air-operated jackhammers. The coal is hand-loaded on shaking conveyers and conveyed to the haulage road at the bottom of the longwall face where it is either discharged into mine cars or on to a 30-inch belt conveyer for transfer to mine cars at constructed loading points. In some cases it is necessary to support the roads through the longwall wastes with steel arches.

In 1945 the Dosco companies in the Sydney field employed 8,131 men at the mines, as compared with 8,764 in 1939. Of the 1945 force, Dominion Coal Company employed 7,152 and Old Sydney Collieries 1,285. Production per-man-day figures covering 1945 and 1939 for the two companies were as follows:

—	Mining Labour		Underground Datal		Total	
	1939	1945	1939	1945	1939	1945
Dominion Coal Company	7.6	5.7	5.3	2.8	2.7	1.6
Old Sydney Collieries	5.0	5.3	4.8	4.1	2.1	1.9

Independent Companies

The independent companies operate five mines in the Sydney coal field, all of which are located in the Sydney Mines district. All the companies operate on sub-leases from Dosco subsidiary companies. The Bras d'Or Company has two mines, the Toronto or Colonial No. 1 mine operating on the Phalen (Collins) seam, and the Franklin mine operating on the Bouthillier (Edwards) seam. The Indian Cove Coal Company also has two mines, the Greener mine and the Tomson mine, which operate in the Back Pit (Indian Cove) seam which lies immediately above the Phalen seam. The Sullivan mine, which is operated under common management with the Indian Cove mines, also works the Back Pit seam.

Room-and-pillar methods are used in all of the mines, and mechanization is limited, being confined largely to the Franklin mine where standard electric undercutting machines with electrically-driven shaking conveyers, duckbills and drills for shot-hole boring are used. The Franklin mine has a screening plant which is adapted for making fine sizes for stoker fuel and for dustless preparation of such sizes.

About 400 men are employed in these operations, some 280 of whom are employed by the Bras d'Or Coal Company. Production per-man-day averages between 1.5 and 1.6 tons in these mines.

Present Productivity

It will be noted from the production records of the Dosco companies that there has been a serious decline in overall per-man-day production since 1939. The figures for the Dominion Coal Company show production in 1945 was 1.6 as compared with 2.7 tons per man in 1939. Those for Old Sydney Collieries show a decline from 2.1 in 1939 to 1.9 in 1945. This decline has seriously impaired the position of Sydney coal in competitive markets. We are advised that the primary factors leading to this recent trend in productivity are:

(1) A lack of balance between producers and non-producers,

(2) Abnormal absenteeism,

(3) Unsatisfactory industrial relations.

The following statistics supplied by the Dominion Coal Company indicate the fluctuations in the balance between producers and non-producers in the company's mines from 1939 to 1946:

Working Force	1939	1941	1943	1944	1945	1946 (To Sept. 30)	1946 (October)
Surface datal	915	938	931	981	966	992	996
Underground datal	3,566	3,591	3,570	3,803	3,846	3,950	3,918
Mining labour	2,740	2,289	1,966	2,080	2,037	2,210	2,350
Total labour	7,221	6,818	6,467	6,864	6,846	7,152	7,264

It is apparent from the table that the initial imbalance arose out of a decline in the number of producers, or mining labour. This shortage arose out of enlistments and attraction to other employment. By 1941 the number of producers had been reduced by 450. Following this, efforts were made by government agencies, including National Selective Service, to assist in correcting this position. These efforts included freezing the workers to the mines, provision for compulsory transfer of qualified miners from other employment, and their return on special leave from the Armed Forces. In co-operation with the provinces, the qualification requirements governing working at the face were modified and training schemes, supplementary to those of the operators, were implemented. These efforts by 1944 seem to have offset to a limited extent a low of 1,966 producers in 1943 but a shortage of 703 is still apparent in the 1945 figures and in October, 1946, the figure is 390 short of the 1939 position.

The figures also indicate that until 1943 the number of non-producers remained fairly constant, a slight increase in the number of these men being recorded. By 1944 a substantial increase in the number of non-producers is apparent, and this trend has been continued into 1946. Thus, in October 1946 the company employed 433 more non-producers than in 1939. To further illustrate, the percentage of mining labour to the total force in 1939 was approximately 38 per cent; in 1946 the percentage has decreased to approximately 32 per cent. Various reasons have been given for the increased number of datal men employed since 1943, the more recent trend being attributed to the return of men from the services. During recent months the figures include about 150 underground datal men who are attending mining apprenticeship classes.

The actual shortage of producers recorded above was aggravated by abnormal absenteeism. The following statistics were supplied by the Dominion Coal Company from their records of absenteeism among their mine employees for the years 1943 to 1946:

—	1943 Per cent	1944 Per cent	1945 Per cent	1946 (To Sept. 30) Per cent
Surface force	11.95	14.25	16.11	17.99
Underground datal	18.21	22.64	25.55	27.41
Mining labour	23.51	27.26	33.98	35.46
All employees	18.88	22.65	26.58	28.34

It will be noted that absenteeism of all classes of labour in 1946 was 50 per cent greater than in 1943, and we are advised that in that year it was considerably above the normal peacetime average. It will also be noted that the percentage of absenteeism was highest among the producers. This in particular affected production as, in addition to the direct loss of output, it aggravated the imbalance between producers and datal men noted above. The shortage of producers experienced by the Dominion Coal Company was not acutely felt by Old Sydney Collieries. The records of the company, however, show that absenteeism was equally prevalent and followed the same pattern.

Some discussion of absenteeism and relations between the mine workers and the operators appears in the chapter on Industrial Relations. At this point, it is noted that the decline in productivity since 1939 is unrelated to technical mining problems and that the restoration to the 1939 level of productivity appears to hinge on correcting the imbalance of the labour force and securing steady attendance at work and more satisfactory labour-management relations.

Necessary Productivity

As previously noted, the United States mines have achieved in recent years a remarkable record of productivity. As a result of this, even if the mines in the Sydney area recover their pre-war productivity of 2.5 tons per man, this achievement probably will not be sufficient to allow them to retain their pre-war position in competitive markets. The records achieved by the United States mines have been brought about by the development of room-and-pillar methods of work coupled with the development of electrically-operated coal cutters and loading machines and conveying equipment of various types. The use of such methods and equipment permits the production of large outputs from relatively small areas. The concentration of the active working sections of the mine in comparatively small areas reduces difficulties of ventilation and thus facilitates the free use of electricity at the working faces. It also reduces to a minimum the transport system of the mine, with the result that haulage costs are cut in respect to both operating and maintenance charges. The rapid working of areas made possible by the use of the machinery lowers maintenance costs generally, including labour and materials costs, since the coal from the area may be entirely removed before roof control becomes troublesome.

United States experience in the use of these techniques has been that the general morale of the mine workers has been very much higher than under the old system, as most of the drudgery and monotony traditionally associated with the coal industry has been removed with the use of machinery. The system also permits close supervision within the working sections and has proved conducive to the development of team spirit, an essential factor in successful mining operations. Moreover, the adoption of datal pay, which is generally recognized as integral to the successful introduction of these new techniques, has eliminated grievances which had been very prevalent under the contract system of payment.

Operating conditions in the United States central coal fields are exceptional, and undoubtedly favourable conditions partially explain the remarkable records achieved. Before discussing the possible application of United States mining methods in the mines of the Sydney coal field, it is therefore pertinent to compare the operating conditions of the two areas.

The physical conditions of the central coal fields of the United States include flat seams lying under land areas, good roof and floor measures, and shallow cover. By contrast, the seams of the Sydney coal field are pitching and are for the most part submarine, the roof and floor measures are weak, and the workings are under heavy cover.

In the flat-lying American seams entries can be made by shaft or slope almost at will, and the distance from the workings to the surface thus reduced as it is deemed necessary. Haulage from gathering points in the workings can be accomplished by the use of fast-moving locomotives and large mine cars. Gathering locomotives, or equipment serving the same purpose, can rapidly and cheaply assemble the coal from the working faces to those gathering points. The submarine extension of the Sydney coal field necessarily involves increasing haulage distances as the submarine workings project further from the entries at points near the shoreline and there is no ready relief from this situation. The following tabulation showing the seaward extension and depth of workings of the Dosco mines indicates the proportions of the problems encountered.

Colliery	Distance from Shoreline	Distance from Entry	Elevation below Sea Level
	(Miles)	(Miles)	(Feet)
No. 1B	3.7	3.9	1,730
No. 2	2.9	3.6	1,900
No. 4	2.7	3.8	1,680
No. 12	1.4	2.0	2,290
No. 16	1.1	2.0	2,150
No. 20*	2.0	2.7	1,150
No. 24	0.3	1.9	880
No. 26†	2.4	2.6	590
Princess	2.6	2.8	1,780
Florence	2.5	3.2	1,400

* Tunnelled from No. 2 Colliery.
† Tunnelled from No. 1B Colliery.

The dip of the seams in the Sydney field gives rise generally to gradients beyond the limit of 4 per cent where locomotives are serviceable. Electric trolley locomotives are used in mines Nos. 25, 26, 40 and 1B (main haulage) but as the average grade of the field is about 16 per cent, with pitches up to 38 per cent occurring in some localities, rope haulage is generally adopted. There are 33 miles of main rope haulages and a further 5·5 miles of relay rope haulages, the latter occurring in 4 collieries where relays have been required to divide the haulage effort over extended distances. Gathering the coal from the working faces to assembly points is accomplished by rope haulage or, in some instances, by hand-pushing or by horses.

The good roof and floor existing in American mines permit working with a minimum of roof support and roadway maintenance. As close timbering is not required, heavy equipment is manoeuverable. In the Sydney field, the weak roof and floor requires close timbering and costly construction and maintenance of main roads. The close timbering required in most of the working sections restricts the choice of working methods and generally prohibits the use of shuttle cars and the larger units of loading equipment used in some of the United States mines.

The shallow cover obtaining in American mines permits ease of roof control. It also permits the sinking of ventilation shafts at convenient points so that, with relative ease, ample ventilation can be supplied to all parts of the mine with the result that electricity can be safely and conveniently used for all purposes. Disposal of water can be easily accomplished from any point in the workings, since the head against which it has to be pumped is comparatively light. In the Sydney field heavy covers, averaging 1,440 feet and with a maximum of 2,250 feet, cause major problems of roof control and necessitate heavy expenditures for construction and maintenance of support. Ventilation currents must be conducted from entries near the shore to the working places and returned to land exits. There are about 160 miles of constructed and maintained airways in the 13 collieries of the Dosco companies. In one mine, the ventilating currents course as much as 11·9 miles underground. Over 1,100,000 cubic feet of air per minute are forced through the workings of the collieries by electrically-operated fans powered by motors totalling 2,500 horse-power. In several collieries booster fans have had to be installed underground in order to avoid too high ventilating pressures at any point. While the ventilation is ample for some purposes, it has been generally considered inadequate to permit the use of electricity in the vicinity of the working faces and, as a consequence, the more expensive and less efficient compressed air is generally used underground for motive power. To provide this motive power, compressors having a total capacity of 75,000 cubic feet of air per minute, of which 82 per cent is compressed electrically, have been installed. All main haulages and many of the subsidiary hoists are electrically operated, as well as all main pumps. Some conveying equipment outside the working faces and coal cutters in two of the smaller mines where the workings are damp are powered by electricity. The remainder of the electric energy used is consumed on the surface for the driving of compressors, fans, hoists and auxiliary equipment. The use of electricity has increased from 4·75 kilowatt-hours per ton of coal hoisted in 1913 to 25·5 kilowatt-hours in 1944.

Owing to the depth of the mines in the Sydney field, the disposal of water is somewhat more difficult and more costly than it is from the shallow mines in the United States. These submarine mines, however, are remarkably dry, most of the water coming from the old land workings. This is accumulated near the shore-line in lodgments built for the purpose and pumped to the surface without reaching the working sections. The water pumped amounts to 2½ tons per ton of coal hoisted.

The Dosco companies carried on some experimental work with the use of a duckbill loader from 1928 to 1932, but physical conditions in the field and the stage to which the duckbill had been developed at that time were such that no advantage accrued from the use of this equipment. During the same period a re-allocation plan was developed whereby some of the collieries were to be discontinued as producers and sea frontages in whole or in part redistributed to neighbouring collieries to afford the latter greater lateral development. In this way, coal formerly allocated to two collieries could be drawn through the main haulage of one and the roadways of abandoned collieries used for airways for the continuing mine. The plan included developing overlying seams through cross-measure tunnels driven from points approximately 1.5 miles from the shore in existing collieries. When No. 20 colliery was being developed from No. 2 colliery in 1938, the Dominion Coal Company obtained from the United States mobile undercutters and loaders and electrically-driven flight conveyers. Trial runs indicated that the machinery was suitable but the mine workers refused to work the machinery, apparently from fear of a general displacement of labour arising out of general mechanization, and after the mine had been idle for some ten months the equipment was withdrawn.

During the Commission's enquiry, three eminent American engineers have inspected the Dosco mines in the Sydney field, one at the request of the Dominion Coal Company. It is apparent from their reports and from our conversations with Dosco engineers that, from a technical point of view, the United States mining methods can be applied to advantage in at least some of the mines in the Sydney field. The engineers are mutually agreed that with the use of United States equipment the rate of extraction of the coal in any given area will be sufficiently rapid to overcome the conditions which existed in room-and-pillar mining with hand-loading and which forced an extensive adoption of the less desirable longwall system of work, and permit a return to the room-and-pillar system in a number of the mines. The introduction of mechanized loading in some of the mines presently operating under the room-and-pillar system is thought to offer the possibility of gradually improved productivity. We are advised that the adoption of mechanized room-and-pillar mining will result not only in increased productivity of the face workers but in a most material concentration of the workings of the mines. This concentration of workings should permit a substantial reduction of the number of subsidiary haulages required to service the workings of any colliery in which the equipment is installed. This should lead not only to a saving in labour cost but to a very material saving in the maintenance of the roadways because of the shorter total length of roadways required. The concentration of workings should permit a more adequate ventilation without larger quantities of air being forced into the mine as the ventilation available would be directed through fewer working areas. This should permit the general use of electricity throughout the mine and an abandonment of the use of compressed air, with a consequent saving in power costs. In general, in those mines where mechanized room-and-pillar methods can be applied, the overall as well as the producer productivity should be improved and a general reduction in labour, material, maintenance and power costs secured.

The companies have informed the Commission of the plans they have recently developed for the introduction of total mechanization in the immediate future into certain of their mines where conditions are most favourable for its adoption. It may be appropriate to illustrate these proposals by reference to specific mines. Old Sydney Collieries has taken initial steps for the conversion of Princess mine to mechanized room-and-pillar, having ordered certain equipment and received the order in part. This equipment consists of a caterpillar-mounted arc shearing machine, a mobile loading machine, fast boring electric drills, 15-inch flight conveyers for the conveying of the coal in the rooms and cross-cuts, a 30-inch belt conveyer for the headway, and the necessary electric control equipment. The company intends to use this equipment to develop the entries which will be required for the return to a room-and-pillar system. When this development is completed, it is proposed to drive 16-foot wide rooms in series of three for a distance of 300 feet from the entries, and then to immediately draw the pillars formed by the room development. The success of the method will depend almost entirely on the speed with which the workings can be advanced and the pillars withdrawn. The coal from the working section will be delivered by conveyers into mine cars on the level entry, and these will be transported to the main haulage of the colliery in the initial stages of the work by rope haulage, but later on as the level entry is extended the Company proposes to replace this rope haulage by diesel locomotives. At the present time the output of the mine is produced from six working levels. When the conversion to mechanized room-and-pillar is completed, the same output will be obtained from two operating levels.

A somewhat similar installation is contemplated for No. 25 colliery of the Dominion Coal Company, but in this case roof and pavement conditions are much better and the gradient is more gentle than in Princess colliery. For these reasons the Company thinks it will be possible in No. 25 colliery to drive wider rooms without excessively close timbering, thus permitting the use of storage-battery shuttle cars instead of the flight conveyers to be used in the rooms of Princess colliery.

As previously noted, United States mechanized room-and-pillar methods may not be applicable to all areas in the Sydney coal field owing to the severity of physical conditions, and it would appear at the present time that operations in some of the mines may have to continue on the present basis. The question of possible improvements in regard to longwall operations is discussed later. Presently the Dominion Coal Company anticipates that within the period of the next five years 40 per cent of its output or over 7,000 tons of its daily output will be obtained from totally mechanized mines. The Company estimates that the productivity of these mines will be increased to 5 tons per man-day and, with the return to pre-war productivity in the other mines, the overall unit production will be 3.5 tons per man-day on an 18,000 tons daily output. The Company considers that this program will cost about $2,500,000, excluding the necessary outlay for a preparation plant. Old Sydney Collieries believes that its two mines can be totally mechanized and that their productivity can be raised to 5 tons per man-day. The Company's plans anticipate that this will be accomplished within a period of five years at a cost of a little over $1,000,000 excluding provision for preparation.

We are advised that the beneficial results of such a program cannot be achieved in a period much less than the five-year interval included in the plans of the companies. Extensive experimentation is involved and crews have to be trained in the new techniques and to handle the machinery.

Some indication has been given of improved haulage which will accrue from the adoption of mechanized room-and-pillar mining. This improvement, however, will be very limited. Owing to the heavy gradients in the mines, the use of rope haulage will have to be continued and this form of transportation has serious limitations. Moreover, mechanization will be applied to mines which already have established roadways. In these mines track gauges vary between 26 and 36 inches and the mine cars are small, averaging less than ·2 tons in capacity. A considerable capital outlay would be necessary to effect a radical change-over to heavy equipment, adequate returns on which are questionable. It remains, therefore, that the haulage performance in the mines in the Sydney coal field cannot be expected to achieve the records in the flat seams in the competitive mines of the United States. No accurate statistics of the man-day production per haulage worker in the Dosco mines are available but we are advised that 10 tons per haulage worker would be a reasonable approximation. This compares with an average of 50 tons per haulage worker for all United States mines, much higher figures being attained in some of the mines competitive with Nova Scotia mines. Moreover, the limited possibilities of materially improving the transportation system in the mines in the Sydney field leaves unaffected the serious loss of time experienced in transferring the men to and from the working faces. As an average for all the mines 1 hour and 50 minutes per man per day is lost in this process. We are advised that the companies are actively directing attention to the matter of installing faster moving man-rakes and their extension as far as is practical in the mines.

It is inevitable that some displacement of labour will accrue from the foregoing plans for the adoption of mechanized room-and-pillar methods for these plans do not include an increase in the overall production of the Sydney field beyond the normal capacity of existing mines. Increased production per man-day, therefore, will necessarily mean that eventually the output will be secured from a smaller labour force. It is not possible at this time to estimate the extent of this displacement as it will take place over a period of time. Some of the men displaced will be of pensionable age, and a proportion of these will be eligible for pensions under the companies' pension plans. Natural wastage will also reduce the number of men affected. However, displacement will present a difficult problem in the community. The alternative, however, is even more serious as the industry cannot continue on the present level of productivity. This has been increasingly recognized by the mine workers in the area.

It has been indicated that some mines in the Sydney coal field may have to continue with longwall methods. As there is very little longwall mining done on this continent except in Cape Breton, it is natural to find that latest improvements exist in the United Kingdom and Europe where much longwall mining is practised. In England electrically-operated combined cutting, shearing and loading machines are in use, and it is possible that these could be adapted for use under Cape Breton conditions. There is also the possibility that where the pitch is not too steep, mobile loading machines may be used. The introduction of any such machinery into the Cape Breton longwalls must be preceded by serious study of the improvements recently achieved elsewhere, and will involve exhaustive experimentation. We are of the opinion that this should be proceeded with, but we wish to emphasize that, inasmuch as the productivity from longwall operations will not reach the level of mechanized room-and-pillar methods, every effort be extended to adapt the room-and-pillar techniques to areas where it is at all possible.

PREPARATION PLANTS

Preparation of coal for the market at the Dosco collieries is limited at the present time to screening and hand-picking. Generally only lump and slack sizes are made, but in some cases a limited amount of nut coal for stoker use is made. Further sizing is done at storage piles at Montreal where large stocks of coal are stored for distribution in the central Canadian area. Coal supplied to the Dosco steel plant at Sydney and the LaSalle coke plant in Montreal is crushed and washed in a Baum washery at the steel plant.

The introduction of mechanical loading in the collieries will inevitably necessitate the provision of more adequate preparation plants. Inherent in this type of mining is an increased impurity content in the coal as loaded and, in order to maintain the quality of their products, the companies will have to adopt large scale preparation, including washing and possibly dustless preparation for domestic sizes. Assuming that the fine sizes below $\frac{1}{4}$ inch would not have to be cleaned, and that heat drying would be unnecessary, we are advised that it would be possible to build a suitable plant at a cost of $1,000 to $1,500 per ton of hourly capacity. To provide such cleaning facilities for the Dosco mines would probably require an expenditure of approximately $2,000,000.

DEEP SHAFT

It has been suggested that eventually the continued extension seawards of the present mines will become impracticable, mainly because of haulage and ventilation difficulties. The remote submarine areas, it was intimated, may then be mined from shafts 2,500 to 3,000 feet in depth sunk near the coastline, from which level tunnels would be driven through the rock to tap the seams four to five miles from the shoreline. Transport through the level tunnels would be by heavy electric locomotives, thus facilitating the rapid movement of production, materials and men.

Mining of a somewhat comparable nature has been developed in the State mines of Holland but, before it could be adopted on the much larger scale and under the different conditions of the Sydney coal field, an intensive engineering study over a period of years would be necessary. The capital cost of such a project would run into many millions of dollars.

Mainland

Production on the mainland of Nova Scotia is concentrated in the Pictou and Cumberland coal fields; although small scale mines have operated intermittently in the Kemptown area in Colchester County. As previously noted, 545,789 tons were produced from the Pictou coal field in 1944 and 880,799 tons from the Cumberland coal fields.

PICTOU COAL FIELD

Three companies operate in the Pictou coal field, namely, the Acadia Coal Company Limited, the Intercolonial Coal Company Limited and the Greenwood Coal Company Limited. As will be seen from the following production figures, the major operator in the field is the Acadia Coal Company, a subsidiary of Dosco.

—	1944	1937
Acadia Coal Company	353,557	485,564
Intercolonial Coal Company	161,026	230,969
Greenwood Coal Company	31,206	52,894

Acadia Coal Company Limited

The Acadia Coal Company operates two slope mines and one shaft mine in the Stellarton area of the field, and, at the time of writing, is opening a new operation in the Thorburn area. The active mines operate on the Foord, Cage, Third, McGregor and Acadia No. 1 seams.

Mining conditions are most difficult in the Pictou coal field because of a number of factors. Arising out of the drift origin of the deposit, wide variations exist in the thickness and characteristics of the seams and the coal is liable to spontaneous heating. Following the deposition of the seams, extensive folding and faulting took place causing irregular dips and the actual displacement of the seams at comparatively short intervals. This condition is most prevalent in the central Stellarton area. The roof and pavement strata consist of extremely weak shales, so that even under comparatively shallow cover roadway maintenance is costly. The seams are thick, varying from 6 to 40 feet, and in some cases even the latter thickness is exceeded locally, probably due to earth movements subsequent to deposition. The coals in this field are liable to spontaneous heating, particularly in the underground wastes, necessitating carefully selected methods of work and special precautions to prevent outbreaks of fire.

The coal generally is classified as high volatile "A" bituminous, although some of it in the Westville area ranks as medium volatile. In general the coals range from low to medium sulphur content and medium to high ash content. The ash fusion temperatures range from 2,350 to 2,450 degrees, and calorific values from 11,230 to 12,600 B.t.u./lb.

The general method of mining in use is a room-and-pillar system, but because of the liability to spontaneous heating, work is carried on in a panel system. Experience has shown that these panels should not exceed an area greater than 500 feet long and 400 feet wide. Each panel is left surrounded by a fire barrier of solid coal at least 50 feet in thickness. As soon as the rooms in any panel have been driven, the pillars are extracted. As pillar drawing proceeds, great care must be exercised to prevent the presence of oxygen in the extracted area. The waste area is therefore kept under a gas blanket mainly consisting of methane to exclude the oxygen, and it is only by this practice that the fire hazard may be controlled. The entries to any panel are kept to a minimum because when the area is worked out the entries must be sealed and the whole panel placed under a gas blanket. In general, in this system of work the coal is cut by compressed-air-driven radialax machines, and bored by compressed-air-driven jackhammers, although in some cases the coal is cut by hand picks where its nature is such that this can be done to advantage. Coal is loaded by hand into mine cars at the working face, the average capacity of which is a little over one ton.

A small proportion of the output is won by longwall methods. Longwall advancing methods are used as the retreating system proved less satisfactory and more expensive. Longwall is worked wherever conditions will permit because maintenance required in the room-and-pillar method is more costly, as with the longwall method a much larger output can be obtained per foot of roadway driven. Walls are generally two hundred feet in length and operations generally are comparable to the system employed in the Sydney coal field. In the Pictou field, however, extreme care must be exercised in the building of roadside packs in order to prevent spontaneous heating in the longwall waste. The longwall faces are undercut to a depth of 5 feet by compressed-air-driven longwall machines, and are bored by compressed-air-driven jack hammers. Where the gradient is less than 25 degrees, the coal is loaded by hand on shaking conveyers. Where it exceeds 25 degrees, flat sheets are used to transport the coal along the face to the landings where the coal is loaded into mine cars. The average distance from the entry to the working faces in these mines is about 6,000 feet.

Disturbed physcial conditions, however, necessitate many transfers in bringing the coal from the working faces to the surface. Haulage is by rope, in most cases driven by compressed-air-operated engines. Great care must be exercised in controlling the ventilation within working sections in order to minimize the hazard of spontaneous heating and to assist in doing this, air pressures across a working section are kept to a minimum and cross-circuits across totally extracted areas are avoided. Three of the ventilating fans of the Company are operated by electricity, and one is steam driven, steam power being particularly suited for a variable speed control.

The Acadia Coal Company employs currently some 1,300 men. Production per man-day figures for the years 1939 and 1944 are as follows:

—	Mining Labour	Underground Datal	Total
1939	5.3	3.5	1.6
1944	5.6	2.0	1.2

The causes of the decline in productivity since 1939 in this instance are similar to those discussed in the Sydney coal field. Because of the physical conditions existing in the Stellarton area, mechanized room-and-pillar methods cannot be applied in these mines. However, some experimental work has been carried on with a compressed-air-operated loading machine of the rocker-shovel type, and we are advised that this promises to yield a much better productivity where it can be installed.

The Company is at this time engaged in opening a new mine in the Thorburn district which lies in the eastern part of the coal field. In this area physical conditions are very much better than those which exist in the Stellarton area, and it is proposed to employ United States methods throughout the operation, except in a few small areas where the inclination of the seam is too steep to permit their application. The McBean seam which will be mined pitches at 21 degrees at the surface but gradually flattens at depth. Main haulage will, therefore, have to be of the rope type but diesel locomotives will be used for subsidiary haulage. The main motive power to be used in this colliery will be electricity. The colliery, when completed in the latter part of the summer of 1947, will produce 900 tons of clean coal per day, and the Company estimates that a productivity of 5.5 tons per man-day will be obtained.

At the present time the preparation of coal at the existing collieries is confined to screening and hand-cleaning. Lump, slack, and three sizes of domestic coals are made. In conjunction with the development of the McBean colliery, the Company is building a central washery to handle the whole of its output. This preparation plant will produce all sizes of washed coal required for industrial and domestic use. The Commission notes that the domestic sizes will be oil-treated to prepare a dustless fuel as the need for this kind of preparation of Nova Scotia coals for the domestic market is of long standing.

Intercolonial Coal Company Limited

The Intercolonial Coal Company operates three slope mines in the western portion of the Pictou field in the Westville area. Two of these mines work the lower bench of the Westville main seam. The top 9 feet of this 16-foot seam were extracted many years ago. The remaining 6 to 7 feet of the seam are being mined by room-and-pillar methods, but due to the irregular conditions special methods have had to be devised to meet local situations. Mining is by hand-pick and drilling is done with jackhammers or by hand. Loading is by hand directly into mine cars of about one ton capacity. Haulage is mainly by rope but horses are used on subsidiary roads. Operations in the Company's other mine, which is on the underlying Scott Pit seam, are based on longwall advancing methods. Radialax cutters and air-drills are used for development work, and air-driven longwall cutters with 5-foot bars are used at the longwall faces, the lengths of which vary from 155 to 235 feet. In some sections the seam pitches sufficiently to permit the coal to slide on flat sheets, otherwise shaking conveyers are used.

The Company currently employs some 450 men. Production per man-day in 1939 and 1944 was as follows:

—	Mining Labour	Underground Datal	Total
1939	4.8	4.4	1.8
1944	5.8	4.1	1.7

Greenwood Coal Company Limited

The Greenwood Coal Company operates one slope mine in the Thorburn area of the field. The mine operates on the Captain seam, which averages 3 feet in thickness in the present workings. The slope extends some 1,400 feet and the Company has now almost completed the recovery of the reserves available under the existing lease from the Acadia Coal Company. Room-and-pillar mining is practised. Electric cutters are used and loading is done by hand directly into mine cars of about one ton capacity. Haulage is by rope from electrically-operated engines. In 1944 the Company employed about 80 men underground and about 25 on the surface. Man-day production covering all employees in 1944 was about one ton.

It is highly desirable that the Acadia Coal Company should effect an equitable agreement with the Greenwood Coal Company to provide the latter Company access to reserves adjacent to its present operations. The Provincial Government should lend any assistance necessary. As many of the independent companies hold subleases from the Dosco companies, the Provincial Government should review periodically the leasehold situation to ensure the welfare of the small operators.

CUMBERLAND COAL FIELDS

The output from the Cumberland coal fields is almost entirely produced by four companies, one of which, the Cumberland Railway and Coal Company, a wholly owned subsidiary of the Dominion Coal Company Limited, accounted for 67 per cent of the total 1944 production of 880,799 tons. The output of these four companies in 1944 was:

	Tons
Cumberland Railway and Coal Company	595,443
Joggins Coal Company Limited	120,495
Hillcrest Mining Company Limited	92,490
Standard Coal Company Limited	71,095

Mining in Cumberland County is carried on in the Springhill and in the Joggins areas. The three smaller companies operate in the Joggins area, whereas the Cumberland Railway and Coal Company mines are located in the Springhill area.

Cumberland Railway and Coal Company

The Cumberland Railway and Coal Company operates three mines. One of these is a slope mine with its entry driven in the seam. A second mine operates from cross-measure drifts driven from this slope. The third enters the seams it works from a cross-measure tunnel driven from the surface. The three mines deliver their coal to a common bankhead. These mines are currently working four seams: No. 1 seam, a 10-foot seam which is split into two leaves of approximately 4 feet each in the locality of the present workings; No. 2, a 9-foot seam; No. 6, a 6-foot seam; and No. 7, a 4.5-foot seam. The coal is classified as a high volatile "A" bituminous coal. Its ash content averages 9.7 per cent and its sulphur content 1.6 per cent. The calorific value averages 13,225 B.t.u./lb. It has a medium fusion point of ash and is a coking coal.

In the vicinity of the operations the seams dip to the west at about 32 degrees at the outcrops but gradually flatten at depth. At 11,400 feet from the mine entry, the dip of No. 2 seam has flattened to some 12½ degrees, at which point the vertical cover is some 3,821 feet. The workings are not unduly hot at that depth, the temperature being about 67 degrees. The strata consists of strong shales and sandstones and these strong formations permit the total extraction of No. 2 seam even at depth without undue maintenance of roadways. At depth, however, these strong strata are the cause of other serious operational problems. Stresses thrown on them by the removal of the coal are not immediately released but are built up until they reach such magnitude that, in the room-and-pillar system, the pillars disintegrate instantaneously and what is generally known as a "bump" occurs. In some cases where pillars had been drawn over a fairly extensive area without the breaking of the strong roof and where the neighbouring pillars were large and strong enough to withstand the stresses thrown on them, the roof itself broke along the pillar line and caused extensive damage in the neighbouring sections by the reaction which accompanied the relief of the stresses in the roof. For this reason the system of work in No. 2 colliery was changed over twenty years ago from room-and-pillar to longwall retreating. Since that time bumps have occurred but, generally speaking, they have not been accompanied by the widespread damage resulting from bumps in the room-and-pillar system, mainly because the long line of total extraction made possible by the longwall faces permit the roof strata to break off before the accumulated stresses in them become excessive. Moreover, the necessary development work required for longwall retreating has made it possible for boreholes to be drilled into the roof and floor of the seam to determine the character of the strata in the vicinity. Where a strong sandstone band of a thickness of 25 feet occurs in the roof and where the floor is strong, the seam is not worked. This has compelled the abandonment of a number of areas.

In the longwall retreating operations of No. 2 colliery, levels are driven at intervals of 400 feet to the colliery boundary and are connected for ventilation purposes every 500 feet. When the boundary is reached, three walls, having a total length of 1,200 feet, are worked until they reach the slope pillar or until ground where bumps may be expected to occur is encountered. Normally, neither undercutting nor shooting is required, but hand-picks are used to break down the coal adjacent to the roof and the floor. It is loaded by hand on reciprocating conveyers and delivered either to mine cars on the level at the bottom of the wall or on to a flight conveyer which transports it along the level and into mine cars at the loading point. No. 1 colliery, which works No. 1 seam from the slope of No. 2 mine, is operated on a similar basis, the coal in this instance being undercut by a longwall coal cutter and bored by jackhammers. Reciprocating conveyers are used at the face. In sections now being developed, it is planned to use the longwall advancing system. No. 4 colliery, which works No. 7 seam, operates on the longwall advancing system, using similar equipment to that used in No. 1 mine. A new mine is being developed through short cross-measure drifts from No. 4 mine. The Company is preparing to work a room-and-pillar system with duckbill loaders. The seams, particularly No. 7 seam, are gassy. Ventilation is supplied by electrically-operated fans located at the surface. In No. 2 colliery a booster fan is used. Arising out of the heavy gradients, haulage is by rope. Electricity is not used in the vicinity of the face, motive power in these areas being compressed air. All main pumps, fans and auxiliary hoists are electrically operated. The surface hoists and air compressors are steam driven.

In 1944 the Company employed 1,360 men. The productivity figures for 1939 and 1944 are as follows:

—	Mining Labour	Underground Datal	Total
1939	5.1	4.4	2.0
1944	5.7	2.6	1.5

The coal produced by the three collieries is prepared in a common preparation plant. The plus 4-inch coal is hand-picked while the 1-inch by 4-inch is washed through a Vissac jig. The minus 1-inch coal is separated into ¼-inch by 1-inch and minus ¼-inch. The fine slack is used in pulverized fuel boilers in the Maritime Provinces. After washing, the coal is screened into egg and nut sizes. Any size of coal coming from the preparation plant may be loaded separately or may be mixed for loading as required.

Joggins Area

The mines of the three principal operating companies in this area work two of the five seams, the Forty Brine and Kimberley seams, the average thicknesses of which in the areas mined range from 28 to 36 inches. To the east and at depth, the seams thin progressively and deteriorate in quality. The field is cut by numerous cross-faults of sufficient displacement to hamper mining operations, in some instances having permitted the infiltration of water and forced the abandonment of mines. The mines in the area are all slope mines and both room-and-pillar and longwall methods are used. Where cutting-machines and other mechanized mining equipment are used, they are electrically driven. The coal is classified as high volatile "A" bituminous but is of low grade, due to high ash and sulphur content. Calorific values average about 10,900 B.t.u./lb. Coal preparation is limited to screening.

The three principal companies employ nearly 500 men. Considering operating conditions, the mines have achieved commendable productivity, average per man-day production in 1944 being about 2 tons. One of the companies, the Joggins Coal Company, averaged 2.5 tons per man-day.

NEW BRUNSWICK

Production in New Brunswick is concentrated in the Minto coal field. A few small mines operate intermittently in the Beersville area but in aggregate they do not produce 400 tons a year. The Minto coal field is divided into many leaseholds and includes a large number of small mines. Production in 1944 was 345,123 tons as compared with 364,714 in 1937 and a peak production in 1941 of 523,344. In 1944 seven operators produced over 96 per cent of the total production. A recent arrangement between the Minto Coal Company and the Miramichi Lumber Company Limited has in effect reduced this number to six. These operators form The New Brunswick Coal Producers' Association. Operations in the Minto field include both stripping and underground mining, the former accounting for approximately 38 per cent of the total output.

Normally only one seam is mined and this seam ranges in thickness from 16 inches to 30 inches, averaging about 18 inches. In some areas, however, a thin lower seam 2 to 6 inches in thickness is mined in conjunction with the main seam. The main seam is flat-lying and is fairly uniform in thickness and quality over large areas, the only variable features of any importance being the presence of one or more partings and an occasional fault of small displacement. The coal is of high volatile "A" bituminous rank. It is of low grade, the ash content averaging about 19 per cent and the sulphur content about 7.5 per cent. The coal is highly fractured and breaks down readily, run-of-mine coal normally containing about 66 per cent of $1\frac{1}{2}$-inch slack. Calorific values range from 9,570 to 12,520 and average 11,610 B.t.u./lb. In about two-thirds of the area, the coal lies within 50 to 170 feet of the surface. In the remaining third, it occurs within 20 to 50 feet of the surface. It is usually underlain with 2 to 5 feet of grey shale. The roof is generally weak, but in some instances consists of massive sandstone. Mine gases are not of any great operational importance. Owing to the low altitude of the area, considerable difficulties are incurred in respect to water, notably in areas to the dip of the seam. The mines pump from 30 to 72 tons of water per ton of coal hoisted.

Underground mining is normally carried on by room-and-pillar methods. Entry to the mines is usually by shafts, the location of the entries being determined by the local drainage situation. The single entry system is common but double entries are used in a few mines. These entries are driven as narrow as possible due to the difficulty of roof support. Apart from the Minto Coal Company, which uses an electrically-driven coal cutter in its longwall operations and hand-loading to shaker conveyers, none of the mines are mechanized. Drilling is done by hand. Mine cars are small and are hand-pushed to and from the shaft.

Existing stripping operations have been confined largely to areas where the overburden is predominantly glacial till rather than rock. Typical units are small, both in respect to areas under operation and machinery used. Normally the latter consists of a steam-driven drag line with a 90 to 100-foot boom and a 3-cubic yard bucket. Practically all of these drag lines date prior to 1932. Surface water presents serious difficulties. Most pits contain an abundance of water which interferes with the loading of coal and to a much larger extent with its transportation from the pits, which become quagmires in rainy weather. Some of the roads from the pits to the railroads are almost impassable during rainy weather, and the wet coal is largely unmarketable in winter months due to freezing. The ratio of cubic yards of overburden to one ton of coal recovered is 15·8.

The following table gives the output and tons per man-day production of the principal companies for 1944.

Name of Company	Production Tons	Tons per Man-Day
Minto Coal Company	122,588	1.4
Avon Coal Company Limited	47,466	1.7
Miramichi Lumber Company	40,386	1.3
Rothwell Coal Company	39,693	1.2
King Coal Mines	22,270	1.2

An average production of 1·14 tons per man in underground mining in 1944 is raised to 1.45 when stripping operations are included.

The nature of the coal deposits and the physical difficulties are such that mining in New Brunswick will remain very largely a local industry. The stripping operations could be improved by the use of more modern equipment but no material improvement in underground operations can be anticipated. In general it would appear that the coal resources of the Minto coal field are too limited to permit the current multiplicity of leaseholds and operations to continue with any reasonable expectation of efficient operations. Some consolidation might contribute to the introduction of larger scale stripping operations, the underground recovery of coal from the most accessible points, and a reduction of mining costs generally by systematic drainage of the district. It has been suggested that the field might benefit by a central washing plant located at the New Brunswick electric power station at Grand Lake. It is doubtful whether such a proposal is practical or economically sound. This is a question which must be resolved by the operators.

SASKATCHEWAN

The total output of Saskatchewan mines in 1944 was 1,372,766 tons as compared with 1,049,348 tons in 1937 and 579,424 tons in 1930. Some small scale mining has been carried on intermittently in the Upper Cretaceous deposits occurring in western Saskatchewan but production is concentrated in the Tertiary deposits in the south and, in particular, in the Estevan area of the Souris River Valley district in the south-east. These Tertiary lignite deposits extend from the Manitoba—Saskatchewan border almost to the Alberta boundary, and some small mines produce for local consumption in the westerly Cypress Hills and Wood Mountain—Willowbunch districts. Some 30 mines operate in the Estevan area, 13 of which are shipping mines. These shipping mines account for approximately 97 per cent of the total output of the Saskatchewan mines, of which there are about 85. In 1944, four companies accounted for over 90 per cent of the total output and two of these produced about 80 per cent of the total. The output of these companies and their per man-day production in 1944 were:

—	Production	Man-Day Production
	tons	tons
Western Dominion Coal Mines Limited	706,536	12.3
Manitoba and Saskatchewan Coal Co. Ltd	401,853	9.1
Eastern Collieries	91,887	14.0
Roche Percée Coal Mining Company Limited	50,843	13.0

The increase in production in Saskatchewan since 1930 is largely the result of the introduction of large scale stripping operations in the Estevan area. Approximately 85 per cent of the output of the four larger companies comes from stripping operations, the underground production coming from the Manitoba and Saskatchewan Coal Company, which secures nearly 60 per cent of its output from deep seam mining.

The coal is recovered from four of the eight seams in the area. These are numbered in descending order and have average thicknesses of 5, 5, 7 and 10 feet. They occur generally within 200 feet of the surface and are flat-lying. The seams mined are separated by intervals averaging 52, 20 and 25 feet. Stripping operations are concentrated on the Estevan or No. 3 seam which has a relatively shallow overburden north of the Souris River Valley. The coal classifies as lignite. Moisture content averages 35 per cent, ash 6.1 to 9.3 per cent, sulphur 0.4 per cent. Calorific values range between 6,905 and 7,420 B.t.u./lb.

The large open-cut mine operated by the Western Dominion Coal Company is equipped with a 10-yard 320-B Bucyrus-Erie power shovel and a 5-yard 5-W Bucyrus Monighan walking dragline. These draglines strip the overburden which averages between 15 and 24 feet but at certain points reaches a maximum of 50 feet. The exposed coal is then cleaned with bulldozers and shot lightly with black powder. Two power-loading shovels of 2.5 and 3.5-cubic yard capacity load the coal into 20-ton Euclid trucks, of which the Company has seven, for transportation to the tipple where the coal is screened and, where necessary, crushed. The smaller companies, two of which contract part of their operations, use diesel tractors, bulldozers and scraper equipment to remove the overburden, and the shovels and trucks are smaller, corresponding with the size of their operations. Preparation includes crushing and screening. The transportation arrangements as well as stripping and loading operations of these companies are generally efficient.

The underground operation of the Manitoba and Saskatchewan Coal Company is a shaft mine, the shaft being 65 feet in depth. Room-and-pillar mining is used. Rooms 25 feet wide on 35-foot centres are turned at 45 degrees from the panel entries. The pillars are not drawn. In the locality of the mine the coal seam ranges in thickness from 9 to 14 feet. Seven feet only of the seam are recovered as some of the coal is left as floor and some as roof to reduce timbering cost. As there is no gas, little water, and a uniform seam with a working height of about 7 feet, mining conditions are excellent. Operations at the face are generally mechanized on the basis of electricity although there is some hand-loading. Trolley locomotives, one 10-ton, two 8-ton and one 5-ton, are used on the main haulageways but only one loading machine is served by a gathering locomotive; gathering is generally accomplished by the use of horses. Track is 42-inch gauge with 40 to 56-pound rails and the wooden mine cars used are about 2.5-ton capacity. The coal is screened over a modern 5-track tipple into box cars and hauled on the company railroad to the C.P.R. or C.N.R. tracks at Bienfait.

From a technical point of view, the efficiency of this underground operation could be increased by the installation of larger mine cars, the use of locomotives for gathering from the loading machines, and the replacement of the shallow vertical shaft by a slope equipped with belt conveyer. The Company is aware of the desirability of improvements along these lines but is faced with the difficult task of assessing the return which would be received from capital so invested in view of the intense competition from the strip mines. Underground operations in the Estevan area are more affected by the seasonal nature of the Saskatchewan coal mining industry than are the strip mines.

ALBERTA

Production in Alberta in 1944 amounted to 7,428,708 tons, of which 4,765,884 tons were bituminous coal and 2,662,824 tons were sub-bituminous. The bituminous tonnage includes a small quantity of semi-anthracite from the Cascade area near Banff, and the sub-bituminous output includes a small amount of lignite from the Pakowki area in the southeastern part of the Province. In 1944 there were 196 operators, most of whom were producing for purely local consumption. The following tabulation groups the operators according to their annual output. The figures also indicate a decrease in the number of operators since 1930, a trend which has accompanied an increase in the annual output of the Province.

Year	Production tons	Number of Operators					
		Total	Under 1,000 tons	1,000 to 10,000 tons	10,000 to 100,000 tons	100,000 to 200,000 tons	Over 200,000 tons
1930	5,755,528	290	165	63	43	11	8
1935	5,462,894	313	166	81	51	9	6
1940	6,203,839	283	134	86	44	9	10
1944	7,428,708	196	69	70	35	7	15

SOURCE: Dominion Bureau of Statistics.

It will be recalled from previous discussion of Alberta coal reserves that the deposits occur in fifty areas and that these may be grouped in four regions, Inner and Outer Foothills belts adjacent to and in the Rocky Mountains and two

Plains regions on the eastern side of the Alberta Syncline. The location of these fifty areas and their grouping is apparent on Maps 8 and 9 appearing in the chapter on Coal Reserves. Mining operations are confined to thirty-two of these fifty areas. The following table gives the output of coal in Alberta by area and rank in 1939 and 1944.

OUTPUT OF COAL AND NUMBER OF MINES BY AREA AND RANK

—	1939	1944	Percentage of Total Output 1944	Percentage of Bituminous or Sub-bituminous 1944	Number of Operators 1944
	(Tons)	(Tons)			
Bituminous—					
Cascade	194,451†	363,314	4.9	7.6	2
Nordegg	151,107	351,869	4.7	7.4	1
Crowsnest	1,400,802	1,943,277	26.1	40.8	7
Mountain Park	810,584	892,954	12.0	18.7	4
Coalspur	360,436	651,340	8.8	13.7	6
Lethbridge	329,416	481,844	6.5	10.1	7
Saunders	40,736	63,926	0.9	1.3	2
Pincher	1,374	660	–	–	1
Pekisko	5,385	5,864	0.1	0.1	2
Prairie Creek	104,063	7,637	0.1	0.2	1
Magrath	431	–	–	–	–
Morley	107	2,581	–	0.1	1
Halcourt	2,992	618	–	–	4
Total	3,401,884	4,765,884	64.1	100.0	38
Sub-bituminous—					
Drumheller	1,223,337	1,678,322	22.6	63.0	23
Edmonton	472,132	389,333	5.2	14.6	26
Tofield	47,667	101,895	1.4	3.8	4
Brooks	10,980	88,365	1.2	3.3	2
Taber	12,781	74,936	1.0	2.8	6
Pembina	38,955	72,251	1.0	2.7	5
Camrose	54,693	65,303	0.9	2.5	7
Sheerness	36,784	49,780	0.7	1.9	8
Carbon	80,032	46,896	0.6	1.8	14
Castor	38,110	40,896	0.6	1.5	28
Gleichen	26,091	16,430	0.2	0.6	6
Redcliff	26,104	10,603	0.1	0.4	2
Champion	15,273	7,177	0.1	0.3	3
Ardley	15,694	7,109	0.1	0.3	10
Big Valley	2,447	5,471	0.1	0.2	4
Rochester‡	5,069	4,257	0.1	0.2	2
Milk River	5,961	1,624	–	0.1	2
Wetaskiwin	3,224	1,085	–	–	1
High Prairie	–	588	–	–	1
Whitecourt	229	287	–	–	3
Pakowki	1,464	216	–	–	2
Pakan	202	–	–	–	–
Sexsmith	95	–	–	–	–
Total	2,117,324	2,662,824	35.9	100.0	159
Alberta Total	5,519,208	7,428,708	100.0		197§

SOURCE: Dominion Bureau of Statistics.
† Includes 10 tons mined in Highwood District.
‡ Westlock included with Rochester area.
§ Total should read 196 but one company operates in two areas.

Production of low, medium and high volatile "A" bituminous coal is concentrated in four areas in the Inner Foothills belt, namely, the Crowsnest, Cascade, Nordegg and Mountain Park areas. The mines in these areas account for nearly 48 per cent of the total Alberta output and nearly 75 per cent of the total bituminous production in the Province.

High volatile "B" and "C" bituminous coal is mined in the Outer Foothills belt and in the Lethbridge and Halcourt areas in the Plains. Production in the Foothills is largely confined to the Coalspur and Saunders areas. A very small tonnage is produced in the Halcourt area but the Lethbridge mines account for approximately 39 per cent of the total high volatile "B" and "C" bituminous production.

The sub-bituminous coal is mined in the Plains, 10 of the areas accounting for 98 per cent of the total sub-bituminous output. Two areas, Drumheller and Edmonton, produced nearly 78 per cent of this output.

A different grouping of the industry is suggested in a consideration of the markets served by the mines. The high rank bituminous coals mined in the Inner Foothills belt are largely sold for railway and industrial use, the mining companies being commonly referred to as the "steam" coal operators. The output of high volatile "B" and "C" bituminous coal from the Coalspur and Saunders areas in the Outer Foothills belt mainly reaches the domestic market, a substantial tonnage however going to the railways. Production in the Lethbridge and other Plains areas is chiefly for domestic purposes. This grouping has some considerable merits for our purposes as the problems of the "steam" and "domestic" mines are in some instances distinct. For example, a price premium exists on lump-sized coal for domestic use and the "domestic" operators must necessarily select in these circumstances mining methods calculated to produce a high proportion of lump coal. Again, the "domestic" mines are more seriously affected by the seasonal fluctuations of the coal market. As some 1,300,000 tons are approximately 17 per cent of the total Alberta output is secured from strip-mines, it is also possible to divide the industry between stripping and underground operations. The different physical conditions encountered by the mines in various areas is also an important factor in grouping the industry. Broadly speaking, the mines in the Foothills belts work seams which have been folded and faulted by mountain building forces and the coal is often crushed and very friable. The pitching seams of the Foothills belts contrast with the flat-lying seams of the Plains regions. Roof pressures in the Plains are normally very much less severe than in the Foothills belts and the mines are less gassy.

In the discussion which follows, the Alberta coal mining industry has been grouped by taking a balance of these various factors and the division is as follows:

1. The principal mines operating in the Inner Foothills belt where the seams are pitching and the market served is industrial and railway.
2. The principal mines in the Coalspur and Saunders areas of the Outer Foothills belt where physical conditions are similar to those in the Inner Foothills belt, and where the market is industrial, railway, and domestic.
3. The principal mines in the Drumheller, Lethbridge and Edmonton areas, the most important producing areas on the Plains, where the seams are flat-lying and the market is domestic.
4. Stripping operations.

Inner Foothills Belt

Thirteen companies operate in four areas of this belt, nine of which account for nearly 99 per cent of the total output. These companies, together with the Crow's Nest Pass Coal Company which operates mines in the adjacent British

Columbia coal fields, form the Western Canada Bituminous Coal Operators' Association. The areas in which mines operated by the Alberta companies are located, their annual production, average number of workers employed and output per man-day in 1939 and 1944 appear below:

—	1939			1944		
	Output	Output per Man-Day	Average No. of Employees	Output	Output per Man-Day	Average No. of Employees
Crowsnest—						
West Canadian Collieries Ltd....	522,049	4.58	614	972,865	3.69	941
International Coal and Coke Co. Ltd..........................	353,552	3.85	438	425,792	3.53	516
Hillcrest Mohawk Collieries Ltd.	....	....	....	293,299	3.64	315
McGillivray Creek Coal and Coke Co. Ltd.......................	297,524	3.41	376	249,813	2.82	338
Cascade—						
Canmore Mines Ltd.............	192,957	3.15	273	361,318	4.32	311
Nordegg—						
Brazeau Collieries Ltd..........	151,107	3.55	218	351,869	3.50	439
Mountain Park—						
Cadomin Coal Co. Ltd..........	295,424	3.39	300*	327,017	2.68	285
Luscar Collieries Ltd............	164,386	3.32	168	274,295	3.55	277
Mountain Park Collieries Ltd....	313,500	3.70*	324	248,811	3.30	277

*Estimated

The mining conditions under which these companies operate vary considerably. Characteristically the seams are thick and vary greatly within short distances. Due to mountain-building forces and earth movements, the seams are folded and serious faults occur. The dip of the coal beds ranges from 10 degrees to 60 degrees, in some instances levelling off at depth of about 2,000 feet to some 6 degrees. In some instances, notably in the Mountain Park area, the seams are completely overturned. The coal which, as previously noted, ranges in rank from low volatile to high volatile "A" bituminous has a medium to high ash content and is low in sulphur. Average calorific values range from 12,490 to 13,910 B.t.u./lb. and the fusion point of ash is high. Roof and floor conditions fluctuate, roof control in some areas requiring constant attention due to severe pressure at depth. Generally the mines are gassy, and in some instances water difficulties occur.

Entry to the mines is normally by slope or drift. A number of the companies, including West Canadian Collieries Limited in its Bellevue mine, International Coal and Coke Company Limited, Cadomin Coal Company Limited and Luscar Collieries Limited, have secured access to the seams by means of rock tunnels driven across the measures. This practice has been found successful in reducing the expense of maintaining roadways.

These companies carry on both underground and open-cut mining. West Canadian Collieries in the Crowsnest area is presently prospecting an open-cut operation. One of the four mines operated by the Cadomin Coal Company in the Mountain Park area is a strip-mine and accounts for approximately 70 per cent of the Company's output. Luscar Collieries in the Mountain Park area also strips some coal at its No. 3 mine. In another area where the seam is nearly vertical and varies in thickness from 40 to over 100 feet, the surface has been stripped and deep holes drilled to reach the counter level in No. 2 mine. The coal is shot and drawn into chutes from whence it is loaded into mine cars and hauled out through No. 2 mine drift mouth. This operation is locally referred to as the "glory hole".

The method of mining underground is usually room-and-pillar but in some instances a small proportion of the coal is recovered by a modified longwall system. Where coal cutting is required, compressed-air picks are typical but in many instances cutting is not required. Chain-cutters are used in a few instances in entry driving and in the modified longwall operations. Some radialax machines have been used, largely for experimental purposes. Where the pitch of the seams is favourable (over 20 degrees), it is the general practice to drive rooms up the pitch and work the coal to the haulage entry over sheet iron slides. Where the gradient is unfavourable, conveyers and in some instances horses and hand-pushing are employed. Haulage is usually direct or main-and-tail rope haulage, compressed-air locomotives being used by some of the companies underground where gradients permit and for haulage from the top of the mine slope to the tipple. West Canadian Collieries, for example, has 15 of these locomotives in operation. Electricity is not used underground but there has been a steady increase in its use at the surface over the last five years.

The mines all have facilities for coal washing and screening, a number of the companies dust-proofing with calcium chloride coal sold for domestic purposes. International Coal and Coke Company operates 104 Beehive coke ovens in the manufacture of metallurgical coke. In 1944, the Company produced 68,000 tons of coke. In the Cascade and Nordegg areas where the low volatile coals are particularly friable, excessive volumes of fines are secured from mining operations. To secure a market for these, a considerable proportion of the output is briquetted. An asphalt binder is used and the briquettes command a premium as a railway locomotive fuel and for domestic purposes.

In recent years considerable experimental work using various types of air-driven track loaders, pit car loaders, conveyers and scrapers has been carried out by these companies in order to overcome shortages of manpower and to improve their competitive position in the market. The results in many instances have not been entirely satisfactory and modifications are being studied. The most favourable progress has been made in entry driving where air-driven track loaders have proved satisfactory in driving rock tunnels and loading coal in the entries. The operators are keenly aware of the necessity of improving their competitive position by adopting the most modern machinery and techniques where these can be applied to the peculiar physical conditions in which they operate. Fluctuations in market conditions have been responsible for some of the delay in securing the improved productivity implicit in increased mechanization. Whereas in 1944 the "steam" mines operated at an average of 265 days, in 1939 they averaged 186 days and in 1934, 143 days. It has not been apparent to the operators that in these circumstances there would be an adequate return of capital so invested. The improved market conditions of the war period and their recent experimental work with machinery have placed the companies in a better position to measure the merits of more extensive mechanization.

Outer Foothills Belt

Production in this belt is very largely concentrated in the Coalspur and Saunders areas. Two of the companies operating in the Coalspur area, Sterling Collieries Limited and Coal Valley Mining Company Limited, operate strip mines. The annual production, employment and output per man-day of the four principal companies in the Coalspur area and the two companies in the Saunders area for 1939 and 1944 appear below:

—	1939			1944		
	Output	Output per Man-Day	Average No. of Employees	Output	Output per Man-Day	Average No. of Employees
Coalspur—						
McLeod River Hard Coal Co. Ltd	37,478	3.62	78	217,472	3.37	259
Sterling Collieries Ltd	118,335	5.07	78	143,180	5.50	82
Coal Valley Mining Co. Ltd	128,124	5.58	62	137,240	5.26	79
Foothills Collieries Ltd	45,331	2.80	76	117,204	3.83	117
Saunders—						
Bighorn and Saunders Creek Collieries Ltd	22,318	2.42	62	39,407	2.16	70
Alexo Coal Co. Ltd	18,307	2.33	52	24,519	1.80	47

The coal deposits in these Outer Foothills areas are geologically younger than those of the Inner Foothills belt, being mainly of Upper Cretaceous age. The mountain pressures which matured these younger coals to bituminous rank also disturbed the coal seams so that physical conditions are similar to those in the Inner Foothills belt. There are three principal seams in these areas separated by stratigraphic intervals of about 200 feet. The Upper Val d'Or seam is generally in two leaves separated by a heavy parting, the upper part being about six feet while the lower part is about ten feet. The underlying Silkstone seam is in some areas as much as 14 feet thick. The lowest or Mynheer seam, where mined underground, ranges between 12 and 16 feet in thickness. In areas where the seam is being stripped, the total thickness of coal ranges from 50 to 200 feet, much of which is recoverable within a limit of 250 to 300 feet of overburden. In the Coalspur area where the strip mines are operating, earth movements have led to an even greater concentration of coal. There is a wide range in the quality of the coals mined in these areas. Most of them are hard and will withstand handling and exposure to weather. However, where the seams have been subject to severe faulting, they are friable. Their ash content is somewhat lower than the coals of the Inner Foothills belt and the sulphur content is negligible. Calorific values range from 10,360 to 11,400 B.t.u./lb. The fusion temperature of ash is medium.

The method of mining underground is room-and-pillar, rooms being usually turned up the pitch. Rooms are turned on the advance and, in most instances, the pillars are not drawn. Cuttings are commonly left in the mines owing to the difficulty of securing a market for fine sizes. Mechanization is not extensive although there has been some improvement during the war period, notably in the case of the McLeod River Hard Coal Company which was acquired by Canadian Collieries (Dunsmuir) Limited in 1941. In the smaller mines the haulage on the levels is by horse, and slope haulage is by rope. The McLeod River Hard Coal Company now employs a battery locomotive in one of the mine levels and has acquired an air-driven track loader for entry driving. Entries are also advanced by hand-shovelling onto shaker conveyers. Coal is not extensively prepared in these areas and preparation is largely limited to screening. From a technical point of view, the productivity of these mines could be improved by increased mechanization, and it is apparent from their recent initiative that the operators realize the necessity of securing this improvement in order to retain their markets. The seasonal nature of the domestic market which these mines serve and the difficulties of marketing the fine sizes at an adequate price are factors which have delayed investment in the necessary mining equipment.

The two strip mines are operated on the Mynheer seam. The extreme thickness of the coal seam in the areas under operation has been noted; in view of this thickness the stripping operations reach a considerable depth. The average ratio of overburden to coal over a period has ranged from 1.0 to 1.5. Coal Valley Mining Company has several pits in operation or in the prospective stage and drilling has proved the deposit for several miles giving the Company thirty to forty years of future operations on the basis of proved coal. In view of this, the Company has proceeded with the erection of a new cleaning plant with a capacity of 165 tons per hour and a power plant. Sterling Collieries has an inadequate cleaning plant but the life of the present pit has been estimated to be only three or four years.

Plains Regions

The most important mining areas in the Plains are the Lethbridge, Drumheller and Edmonton areas.

Lethbridge

Seven companies operate in this area, all of which, with the exception of Lethbridge Collieries Limited, are small scale mines. Several of these are strip mines. Some particulars of the production records of Lethbridge Collieries, which accounts for about 90 per cent of the area output, appear below:

—	1939			1944		
	Output	Output per Man-Day	Average No. of Employees	Output	Output per Man-Day	Average No. of Employees
Lethbridge Collieries Ltd.	234,768	3.27	366	431,425	3.46	553

The coal beds in the Lethbridge area are flat-lying with a slight dip toward the northwest. Only one of the several seams in the area is worked extensively. This seam varies in thickness from 3 to 9 feet but averages 4.5 and 5.5 feet in the mines operated by Lethbridge Collieries Limited. Typically the ash content of the coal is about 10 per cent and sulphur 0.6 per cent. Calorific value averages 10,900 B.t.u./lb. The fusion point of ash is medium. The coal is accessible by drifts along the streams but entry in this Company's mines is by shaft, one being some 260 feet and the other 360 feet. The roof is generally poor and usually gassy, but some gas occurs in the faults.

The standard method of mining is room-and-pillar and, in general, the pillars are not drawn. Drilling is done by hand-held electric drills. The coal is hand-cut and sheared by electrically-driven coal-cutters and the coal hand-loaded. Haulage is by horse and endless rope. In some instances, the men push the empty cars. The Company has two duckbill loaders in operation in one mine but has discontinued their use in the other mine due to difficulties of varying roof conditions. The Company operates a spiral separator. The productivity of these mines, notably the Shaughnessy mine, could be improved by increased mechanization.

Drumheller

In 1944, 23 companies operated mines in the Drumheller field. Ten of these companies, all members of the Drumheller Coal Operators' Association, account for approximately 90 per cent of the area output. Some particulars of their output in 1939 and 1944 are as follows:

—	1939			1944		
	Output	Output per Man-Day	Average No. of Employees	Output	Output per Man-Day	Average No. of Employees
Rosedale Collieries Ltd	160,454	3.02	336	232,348	2.81	322
Midland Coal Mining Co. Ltd	107,191	3.97	141	224,298	4.01	220
Regal Coal Co. Ltd	140,843	6.0	132	221,590	4.3	205
Red Deer Valley Coal Co. Ltd	70,903	3.8	111	188,098	3.50	238
Murray Collieries Ltd	76,696	4.94	103	142,652	4.25	158
The Monarch Coal Mining Co. Ltd	89,970	4.43	83	128,392	3.92	130
Newcastle Collieries Ltd	69,530	3.73	110	110,135	3.52	149
Brilliant Coal Co. Ltd	68,020	4.71	79	93,036	4.43	94
Hy-Grade Coal Mining Co. Ltd	90,085	3.94	108	92,952	2.95	131
Western Gem and Jewel Collieries Ltd	96,910	3.70	220	69,971	2.55	130

The mines in this area are located on both sides of the Red Deer Valley and three seams are worked. Seam No. 1, the lowest workable seam, has an average thickness of 5.5 feet. Seam No. 2 which lies from 35 to 50 feet above ranges from 3.5 to 5.5 feet. Seam No. 5 averages 3.5 feet in thickness and the interval separating it from No. 1 seam varies in different parts of the field reaching a maximum of 105 feet. The coal is hard and blocky and varies in quality in the three mining sections of the field, namely, the East Coulee, Rosedale and Wayne, and Drumheller districts. The ash content of the coal ranges from 5.8 per cent to 7.2 per cent. Sulphur is about 0.5 per cent. Calorific values range from 9,500 to 10,075 B.t.u./lb., and the fusion point of ash is low. The coal beds are flat-lying and the roof is shale and sandstone, both of which are lense-like. Whereas the roof is good when dry, the sandstone tends to swell and scale. The mines are not gaseous.

Entry to the coal is by slope, shaft and drift. The room-and-pillar system of mining is used generally, with some modifications to meet local conditions. One small mine operates on the longwall system. The mining methods are directed to securing a maximum output of larger sizes of coal owing to the premium which these sizes command in a domestic market. For this reason pillars are frequently not drawn and the cuttings left in the mine. The coal is sheared as well as undercut by machines, and some of the mines use cardox in order to increase the percentage of lump coal. Face loading is generally by hand into mine cars or conveyers, duckbill loaders being used in a few instances at the face. Machines of this type have been installed in six mines but this equipment has been more extensively used for entry driving. Haulage in six of the mines is by rope. In eleven mines storage battery locomotives are employed and in six, trolley locomotives have been installed. Horses are used in most of the mines for gathering.

Recent experience with the use of duckbills and conveyers has shown that they can be used to advantage for driving entries during the summer months and in the room panels during the producing months. It is possible that a substantial improvement in productivity would be secured if mobile loaders were used. This can only be established after experimentation and possibly adaptation of the machinery to suit the conditions of the field. This experimentation is essential if the mines in this field are to maintain their competitive position. The introduction of increased mechanization and the trend in the demand for smaller sized coal for automatic stokers will undoubtedly require a provision for more adequate preparation facilities. Several problems are facing the operators in determining the merits of this further capital investment. The domestic market is inherently seasonal. The operators informed the Commission that over the period 1930 to 1943 their mines worked an average of 158 days per annum. This figure includes days on which only a part of the normal complement of men were employed. Only 118 days were worked with a full complement of men. The coal reserve situation is somewhat uncertain and, until this is removed, an extensive program of mechanization will probably be limited to the few mines which, having recently come into operation, have a life expectancy of at least 25 years.

Edmonton

The Edmonton area is characterized by a large number of small operators, some 26 mines operating in the area in 1944. A number of these mines are strip mines. Five of the mines accounted for approximately 64 per cent of the production, their records being as follows:

—	1939			1944		
	Output	Output per Man-Day	Average No. of Employees	Output	Output per Man-Day	Average No. of Employees
Edmonton—						
The Great West Coal Co. Ltd....	69,760	3.3	94	83,169	2.9	103
Banner Coals Ltd................	35,182	4.0	49	55,168	3.5	70
Kent Coal Co. Ltd................	47,487	3.6	67	44,827	3.1	61
Beverly Coal Co. Ltd............	53,710	4.2	59	41,147	2.8	48
Edmonton Collieries Ltd.........	6,012	2.9	13	26,597	4.3	27

Three of the four commercial seams in the Edmonton area are mined. These seams vary in thickness from 3 to 7 feet and are separated by intervals of approximately 30 and 120 feet. The seams are flat-lying and the mines are non-gaseous. The coal is of slightly lower rank than the Drumheller coal and classifies as sub-bituminous "C" as compared with the sub-bituminous "A" and "B" coals of the Drumheller area. The grade of the coal is fully comparable. Typically they have a calorific value of about 8,725 B.t.u./lb.

Room-and-pillar is the prevailing system of mining and generally the pillars are not recovered. In the Black Diamond mine of the Great West Coal Company Limited, however, the present method is to drive rooms 12 feet wide on 77-foot centres, thus developing blocks 65 feet square. The blocks or pillars are mined retreating. The longwall method is used in the Penn mine of Banner Coals Limited. Most of the coal is undercut with electric coal-cutters and hand-loaded into mine cars. Some experimental work has been done with shaking conveyers and duckbills. In the longwall operation one shaking conveyer is installed on a face 400 feet long. Haulage is by rope, horse and hand-pushing. Two storage battery locomotives have been installed in the Black Diamond mine. Preparation is limited to screening.

There is little doubt that the productivity of the mines in this area could be improved by further mechanization, with particular reference to loading machines and conveyers. These might be used in entries in the summer months and transferred to the working faces during the busy winter months. The operators have to weigh the advantages to be gained from this capital investment.

Stripping Operations

According to the Federal Department of Mines publication, Coal Mines in Canada, there were in Alberta in 1944 some 44 stripping operations or mines from which the principal production came from such operations. Two other companies supplement their underground production by stripping. Statistics of the output of these mines in 1944 are not available but in 1945 they produced 1,301,591 tons or approximately 17 per cent of the total Alberta production. This tonnage included 473,771 tons of bituminous coal and 827,820 tons of sub-bituminous or 10.3 per cent of the total bituminous production and 25.8 per cent of the total sub-bituminous production.

Approximately 90 per cent of these mines are located in the Plains regions. However, a similar concentration is not apparent on the basis of output. Thus in 1945, 473,771 tons, all the bituminous coal so mined, was produced in the Foothills areas and 827,820 tons in the Plains regions. The strip-mines operating in the Foothills have been referred to in earlier pages. The strip-mines in the Plains are widely scattered and generally operate on a small scale and have only local significance. The 10 principal stripping operations in the Plains regions are located in the Tofield, Sheerness, Taber, Brooks, Camrose and Castor areas. In 1944 these included six mines operated under special arrangements with the Emergency Coal Production Board. The 1944 production of these mines, their output per man-day and the areas in which they are located are recorded below. The emergency mines are marked with an asterisk.

Stripping Mines	1944	
	Output	Output per Man-Day
Brooks—		
Birnwel Coal Ltd.*	86,060	13.48
Camrose—		
Camrose Collieries Ltd.*	27,989	2.85
Castor—		
Castor Creek Collieries Ltd.*	4,585	5.30
Sheerness—		
Sheerness Coal Co. Ltd	33,373	10.58
Taber—		
Continental Coal Corp. Ltd.*	29,984	11.99
Western Ventures Ltd.*	26,508	10.68
Majestic Mines Ltd.*	10,223	12.86
Tofield—		
Black Nugget Coal Co. Ltd	11,418	12.70
Dodds Coal Mine	33,367	9.07
Tofield Coal Co. Ltd	54,169	5.35

* Emergency Stripping Mines.

BRITISH COLUMBIA

Production in the Province of British Columbia in 1944 amounted to 2,134,231 tons. Of this, 1,221,621 tons came from the Crowsnest Pass area in the southeastern part of the Province, 774,477 tons from Vancouver Island and 138,133 tons from various Inland areas. Most of the output of the mines in the Inland areas is for local consumption. These mines are located in the north-eastern, central and south central coal fields reviewed in the chapter on Coal Reserves.

Crowsnest Area

The principal company operating in this area is the Crow's Nest Pass Coal Company Limited. The Company operates two mines, located at Elk River four miles east of Fernie and at Michel. In 1944 the output of these mines was 1,064,341 tons as compared with 629,392 in 1939. In the same years, the Company employed 1,094 and 636 employees respectively. The output per man-day in 1944 was 3.8 tons as compared with 4.3 in 1939.

Some eighteen coal seams, with an aggregate thickness of 170 feet, occur in the Fernie Basin area in which these mines operate. Along the Elk River Basin, the seams outcrop at elevations of 1,000 to 1,500 feet above the river and dip steeply eastward, the angle of dip gradually lessening as the beds reach the base of the syncline. Further eastward, the seams turn upwards and are exposed again on the opposite side of the mountain. Where mined, the seams range in inclination from 5 to 45 degrees. The mine at Michel is presently working two seams; seam B ranges in thickness from 5 to 5.5 inches; seam A averages about 12 feet in thickness and lies some 50 to 200 feet below seam B. The Elk River mine operates in three thick seams. Roof conditions vary considerably from a tender top of thin shales interbedded with streaks of coal to strong, heavy shales, sandstones and conglomerates. At depth, these conditions have contributed to the occurrence of "bumps" somewhat similar to those referred to in previous discussion of mining conditions in the Springhill coal field in Nova Scotia. The coal deposits are of medium volatile bituminous rank and constitute the most important reserve of coking coal in Canada. The ash content in the British Columbia Crowsnest is lower than in the Alberta Crowsnest fields and averages about 8.5 per cent. Sulphur content is negligible; the fusion point of the ash is high; and calorific values average about 13,930 B.t.u./lb.

In these mines, both room-and-pillar and modified longwall mining methods are employed. The Michel colliery has been developed by means of two cross measure rock tunnels each approximately 4,800 feet long and four level course entries driven off these rock tunnels into the various seams. Inclines are then driven to the outcrops to the rise at intervals of 1,600 feet. Pairs of rooms are then driven across the pitch on either side of the inclines at intervals of 300 feet for distances of 750 feet. Splits are then driven from room to room at intervals of 50 to 90 feet forming pillars 250 feet long and 50 to 90 feet wide. The pillars are then extracted by longwall or swivel work. All mining machines are driven by compressed-air. Duckbill places and longwalls are cut in some instances by chain type undercutters while in others the coal is cut by radialax machines. Compressed-air picks are provided in all working places. Whereas in some sections of the mine the coal is soft enough to be mined with air picks, most of the coal is shot with permissible powder. Shaking conveyers are used in the splits from the faces to the rooms where the pitch does not exceed 28 degrees. Above this pitch chutes are used. Conveyer belts are used in the rooms delivering to belts in the inclines where the pitch is suitable. The incline belts, or chutes where the pitch is excessive, deliver coal to mine cars in the entries from whence the cars are hauled to the surface by compressed-air locomotives. The method of work in the Elk River colliery is similar to that at the Michel colliery. Horse and rope haulage is more extensively used and at Mines Nos. 9 and 10, which are located at an elevation of more than 700 feet above the colliery plant, a rope and button retarding conveyer system 1,500 feet long is used to transport the coal from the mine portal down the mountain side to the preparation plant. About 20 per cent of the coal is loaded by machinery in the Company's mines and about 70 per cent is transported from faces to entries by shaker conveyers. At both collieries, large modern cleaning plants have been erected. At Michel, the company has two ten-oven batteries of Curran-Knowles by-product ovens with a capacity for coking 220 tons of coal per day. Some Beehive ovens are also in service.

Vancouver Island

Mining operations in Vancouver Island occur in two areas, Nanaimo and the more northerly Comox area. Apart from small salvage operations near Nanaimo, Canadian Collieries (Dunsmuir) Limited is the sole operator on the Island. The company in 1944 produced 760,222 tons with an output per man-day of 3.0 tons as compared with 721,864 in 1939 and an output per man-day of 2.4 tons. The company employs about 1,400 men at the mines. The coal mined is of high volatile "A" bituminous rank, the quality of which varies in the two areas. The ash content in the Comox area is about 12 per cent as compared with 10.7 per cent in the Nanaimo area. Sulphur content in the Comox area is a little over 2 per cent whereas in the Nanaimo area it is 0.4. The calorific value of the Nanaimo coal averages 12,510 B.t.u./lb. as compared with 12,730 in the Comox area. The fusion point of the ash is medium in both areas.

The reserves in the Nanaimo district are rapidly approaching exhaustion and the company now has only two mines operating in this area. The South Wellington No. 10 mine opened in 1937 and is now proceeding with pillar drawing preparatory to closing the mine within two or three years. The White Rapids mine, which works the Wellington seam, was opened in 1945 to recover a local pocket of coal. The seam section runs from 34 to 50 inches in thickness and is mined by longwall methods. Depending on roof and floor conditions, the seam is undercut or overcut on walls 300 feet long. The coal is hand-loaded on shaking conveyers. Duckbills and shortwall cutters have been used for entry driving. The coal is screened at the tipple. Sizes over 2 inches are hand picked and the smaller sizes transported to a washery operated by the company at Nanaimo. The life of the mine is limited to about four or five years.

In the Comox area, the company operates two collieries in the Cumberland area and is presently prospecting in the T'Sable River area. In the Cumberland area only three seams have been workable. They range in thickness from 2.5 feet to 10 feet and vary greatly in quality. The seams have been extensively worked and all the easily accessible coal has been mined. Characteristically, they contain bands of stone and shale and are frequently terminated by barren patches. Both the mines operated by the company are shaft mines and, in both, the longwall mining system is used. Air driven cutters and shaking conveyers are employed. In No. 5 mine, the haulage slope is 12,000 feet down the dip with three relays. The operation is now so extended that it is unprofitable and abandonment is contemplated. No. 8 mine, previously closed in 1914, was re-opened in 1936 and has since been in steady operation. A cross measure tunnel is now being driven to a proven area in a lower seam. It is anticipated that this will extend the life of the mine for a further period. If the T'Sable River deposit which currently is being prospected proves to be a workable area of coal, the mine site will be reasonably close to the Company's cleaning plant and shipping facilities at Union Bay, to which the coal from the mines in the Cumberland area is normally taken. Until the reserve situation has been clearly established, the Company has refrained from installing new equipment and is fully aware of the handicaps arising out of this practice. Improved equipment will be installed if the reserves of the new areas prove adequate.