

NOTES ON MINERAL FUELS OF CANADA: BY R. W. ELLS,
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The rapidly growing importance of the Dominion of Canada, with its ever-increasing development of manufacturing industries, and its general commercial progress, calls for continued research for materials suitable for the generation of light, heat and power. To some extent the latter feature is now being supplied by the production of electricity through the utilization of the numerous waterfalls found in every province, and the power thus furnished will doubtless in a few years be sufficient not only to supply our numerous manufacturing centres, but to do away to a large extent with the use of steam on our great lines of railway. But since the varied climate of our country makes artificial heat a necessity for nearly half the year, and many industries exist for which electrical power is not readily available, a constant supply of mineral fuel will always be required. From this standpoint, therefore, a brief glance at our present known available resources in this line may not be devoid of public interest.

Not so many years ago it was the generally accepted opinion that Canada, as a whole, was largely lacking in this element of a nation's progress. The coal fields of the Maritime Provinces were known to some extent, and had been worked on a small scale for many years, but Ontario and Quebec were regarded as entirely lacking in a natural fuel supply. As regards coal proper, this is practically true for both provinces, yet other materials exist which, as will be pointed out, will furnish a fairly good substitute for bituminous coal. Of the boundless stores of mineral fuel which have been discovered on the great

plains and in the valleys scattered through the sea of mountains in British Columbia, as well as along the Pacific coast, our knowledge even forty years ago was exceedingly limited.

The object of the present paper is to direct attention to the large supplies of this fuel which are found in all parts of the Dominion, and which are suitable for the generation of light, heat and power. The substances available for this purpose include, in addition to the several varieties of coal which range from anthracite to the newest lignite, such minerals as anthraxolite, albertite, oil-shale, petroleum, natural gas and peat.

Coal, etc.

The coals of the Atlantic provinces have been mined for nearly or quite a century. They belong to the Carboniferous period, and in point of age contrast strongly with the immense deposits found on the great western plains, along the eastern slopes of the Rocky Mountains, and further west on the Pacific coast, which belong in part to Cretaceous and in part to Tertiary rocks.

The eastern deposits have been described in numerous reports and papers, both in governmental and scientific publications. The principal areas, considered from the economic standpoint, are in Nova Scotia, where at least four well-defined coal-basins occur. Of these the most easterly, known as the Sydney area, is divided into several portions, in which a number of seams are found, aggregating probably not far from fifty feet of coal. This basin probably represents the western margin of a great Carboniferous area which extends beneath the intervening broad strait which separates Cape Breton from Newfoundland, since in the south-western part of the latter province a well-defined coal basin also occurs. The seams of the Sydney basin extend seaward, and have been worked for many years beneath the water, the extension in this direction forming a coal area of great economic importance.

Other important coal deposits in this island are in the western part, and are found in the Richmond and Inverness basins. In recent years, owing to railway construction, these areas have been rendered accessible, and large quantities are now regularly shipped both by land and water.

On the mainland of Nova Scotia, the most important coal field at present is in Pictou County, and though this field is much faulted in places, it has been worked for a century, and is noted for the immense thickness of the coal beds contained, which in one case reaches nearly or quite forty feet. In the western part of the province, in Cumberland County, the Springhill basin inland, and the Joggins basin on an arm of the Bay of Fundy, are large and important factors as regards a coal supply, and though the seams worked at these two places have as yet never been directly connected, the extension of the beds of the Joggins along the northern limit of the Carboniferous basin has been traced for many miles, and a number of collieries have been located along their outcrop. These have been producers of coal in considerable amounts for a number of years.

The Carboniferous basin of New Brunswick is extensive, comprising more than 10,000 square miles. The formation, however, is comparatively thin, and the coal-bearing rocks are regarded as of Millstone-grit age, and as beneath the Productive measures of Nova Scotia, the thick beds of that province not appearing in this direction. The workable seams in New Brunswick rarely exceed twenty inches in thickness, so that the output can never equal that of the adjacent province, but some thousands of tons are mined yearly and find a ready market. In the Upper Carboniferous formation, also, several small seams are found, but these are not sufficiently large to be mined.

In Quebec seams of coal are almost entirely absent, the only deposit of the kind occurring in Devonian slates, in a small layer two to four inches thick, on the shore of Gaspé Basin, and of no economic value. The oil-fields of this district, though

exploited for a number of years by numerous borings, have as yet failed to produce petroleum in paying quantity; but there are large areas of peat throughout the province, which, by the new process of manufacturing into blocks by drying and pressure, promise to become an important factor in the mineral resources of the province before many years. Borings for natural gas and oil in the valley of the St. Lawrence, between Montreal and Quebec, have shewn that the former occurs at several points in this district, and has been locally utilized to some extent already, though up to the present there has been no large development of these substances such as found in Ontario.

In the latter province true coals are entirely absent; but in the area south of James Bay large deposits of low-grade lignite have recently been found, which, though of poor quality, may become of value as this part of the province becomes opened up for settlement. Anthraxolite is also found in deposits of considerable extent in the old rocks of the area west of Sudbury, which are probably of Huronian age. This, at first, was regarded as possibly furnishing a new source of supply for fuel. The large percentage of impurity in the material, with its low colorific value, has hitherto prevented its utilization for commercial purposes. The large deposits of natural gas and petroleum in the Niagara and Petrolea districts have been largely utilized, the former being piped to several cities in the United States, notably to Buffalo and Detroit, as well as supplying a constantly increasing local demand. The peat deposits of this province are also being utilized for the manufacture of a very excellent fuel suitable for domestic purposes and for the generation of heat in factories and on railways,

The area north of Lake Superior is occupied by crystalline rocks which extend westward to the shores of Lake Winnipeg, where they are again overlaid by sedimentaries of Silurian and Devonian age. The Carboniferous rocks are not found in this direction, but a broad area of Cretaceous sediments commences

a short distance west of the Red river, near Winnipeg, and extends, apparently without interruption, to the Rocky mountains. This formation contains numerous beds of coal, principally of the lignite variety.

These deposits of the west were first brought into prominence from twenty-five to forty years ago. Many of them are high grade and true coking coals, which occasionally pass into anthracite in the eastern slopes of the mountain range, while the great seams of the plains east of the Rockies still remain in the form of lignite to a large extent. Among the most important of the true coals which have been extensively worked since the building of the Canadian Pacific railway, are the large seams found in the Crows Nest pass, and along the valley of the Bow River, near Banff.

The anthracite character of these coals has evidently been developed through the agency of heat induced by pressure during the time of mountain uplift. All these western coals are therefore of much more recent date than are those of the eastern provinces. It is so far as yet known, the true Carboniferous rock of the Rocky Mountains do not contain coal.

Between the eastern outcrop of the Cretaceous rocks of the plains and the coal outcrops of the eastern slope of the Rocky Mountains, immense deposits of lignite and of lignitic coal occur. They are mined at several points, the most easterly being at Souris, near the western boundary of Manitoba. In some places this lignite has a high fuel value, but can be distinguished from true coals, among other things, by the fact that, unlike the bituminous variety, lignite and even the higher grade known as lignitic coal will not coke. Lignite also contains a much higher percentage of moisture than the true coals, this feature in some cases reaching as much as 15 to nearly 20 per cent. Immense beds of this lignite are found along the upper portion of the North and South Saskatchewan Rivers, and further north extend into the Peace River district. It is exten-

sively mined for local use at Edmonton on the North Saskatchewan, and at several places nearer the United States boundary.

Passing westward across the broad chain of the Rocky Mountains there follows a great belt of rocks, presenting a number of formations ranging from the Carboniferous down into the pre-Cambrian, in which no coals may be expected. But about 200 miles east of Vancouver in a direct line, or near Sicamous on the Canadian Pacific railway, coal-bearing rocks again make their appearance. These are of a still more recent date than those of the plains, being for the most part of Tertiary age. Owing, however, to greater alteration, the lignite character of the contained coals has been changed, so that the fuels from these deposits, which occur for the most part as basins resting on igneous rocks, are now in the form of true coals, and in many cases form a fuel of great value. The contained coals are sometimes of large extent, ranging in thickness from thin seams up to great beds of twenty feet, or even in some cases of more than sixty feet in thickness.

Among these important deposits may be mentioned those of the Nicola and Similkameen valleys, lying to the south of the Canadian Pacific railway; of the North Thompson, 40 miles north of Kamloops, and of the Marble Canon a few miles northwest of Ashcroft. Further north, numerous deposits of coal are found, among the most important of these being the recently discovered areas in the Bulkley valley, south of the Skeena river, and not far from the projected line of the Grand Trunk Pacific railway, where large seams of high grade bituminous coals and semi-anthracites are exposed. These promise to be of great value on the advent of the railway. Along the upper waters of the Peace river, also, several large seams of fine coal have recently been located; but at present these are not available owing to distance from transportation.

On the Pacific coast the coal-bearing rocks again change their character and belong to the Cretaceous series. Here, as at Vancouver island, are the large mines of Wellington, Nanaimo, Comox, and Ladysmith, in which area large seams occur, some of which, as in the Wellington district, have been worked extensively for nearly forty years. These not only supply the fuels for the Pacific division of British Columbia, but are shipped very largely to the cities on the American coast, as far south as San Francisco. These coals are of the bituminous variety, generally of excellent quality, and well adapted for coking. Further north, on Graham island, of the Queen Charlotte group, both the anthracite, bituminous and lignite varieties are found. The former, although exploited at intervals for nearly forty years, has never been found sufficiently firm to be mined at a profit. The alteration at this place from the lignite or bituminous coal has evidently been due to heat induced by pressure of the beds against the igneous rocks which form high mountains to the west, whereby the rocks and contained coals have been crushed, while dikes of newer rocks have also penetrated the series. Smaller deposits of anthracite have been found in the coal basin of the interior, occurring under like conditions.

In this interior basin of Graham island, however, large deposits of high grade bituminous coal occur which outcrop at several places in beds of great thickness. This part of the island gives promise when opened up, of becoming one of the most important coal fields of the Pacific slope. The containing rocks of both the bituminous and anthracite varieties are of Cretaceous age, while the eastern part of the island is occupied by Tertiary rocks, in which are found seams of lignite of good thickness.

Still further north, in the Yukon district, large deposits of lignite have been found along the Klondike and several other streams. These have been mined to a small extent locally, and will, doubtless, become important as the country is opened up.

Some of the seams contain coal of very good quality, and in the White Horse district coals of fine quality have been reported.

The northern portion of the Dominion, as along the valley of the Mackenzie river, and even on several islands off the mouth of that great stream, are known to contain coal beds, mostly of the lignite variety, which, however, have not yet been utilized.

Petroleum and Natural Gas.

In addition to the coals so briefly sketched, other sources of supply for heating and lighting are found in the presence of petroleum, natural gas, bituminous shales, anthraxolite, albertite and peat. These, with the possible exception of the last named, have a different origin from the ordinary coals. They, however, constitute a very important factor in the development of the various interests of the Dominion.

Among these, petroleum and natural gas may be regarded as the most important. In Ontario, where these occur in the greatest abundance, the petroleum has hitherto been regarded as derived from rocks of Devonian age, though that these are the original source of the gas and oil has never been conclusively established. In the oil fields of the United States, more especially in the Appalachian area, the source of the oil is as low as the Trenton limestone, while in the western or Pacific states it is found in great abundance in formations as high in the geological scale as the Cretaceous and Tertiary, so that petroleum has even a wider range than coal itself. As for that peculiar form of carbon known as anthraxolite, its range is still lower since it is found in rocks generally styled Laurentian, as well as in the Huronian and Lower Cambrian.

In the Atlantic provinces and in Gaspe, borings for oil have been carried on for more than half a century in rocks chiefly of Devonian age. Owing largely to the fact that these rocks are much broken and tilted, and often inclined at high angles, no important economic results have as yet been obtained from any

of the areas thus tested. Among the principal petroliferous rocks in the eastern provinces are deposits of bituminous shale which are found in New Brunswick, Nova Scotia and in Gaspé. Oil springs are seen at a number of points in the areas occupied by these rocks, and in part these shales are so highly charged with bituminous matter as to yield by distillation from 30 to over 100 gallons of oil per ton. Some of these form a good fuel, burning readily in the grate or furnace, the great drawback to a perfect combustible being the very large amount of residue or ash.

In the present stage of oil distillation as conducted in Scotland, Germany, France, Australia, New Zealand, and elsewhere, there would appear to be a good opportunity for successfully exploiting these bituminous shales for the manufacture of petroleum by distillation, since in the several countries just mentioned, this industry is carried on extensively and profitably on material much less rich in bituminous matter than the shales of our own country.

In natural gas, which is an industry of comparatively recent development in Canada, the advance in production has been very rapid. Large quantities have been found in western Ontario, much of which is piped to the cities of Detroit and Buffalo adjacent to Lake Erie. Natural gas has also been found in somewhat limited quantity as yet in Quebec, in the St. Lawrence Valley, and at several of the borings for oil in the eastern provinces. But little attention has, however, been paid to this industry in this part of the Dominion.

In the great north-west, however, the indications for large developments of gas are favourable. Thus at Medicine Hat, and at other points along the Canadian Pacific railway, at Edmonton, and further north along the upper Athabaska river, it has been found, and in some places has already been applied, to the purposes of lighting and heating. At the last named

locality it was struck in immense volume in connection with the borings made some years ago by the Dominion government for petroleum, the rush of the gas being so great that the borings were suspended. At this place it has been constantly escaping for the last ten years, no attempt having been made till recently to check the enormous waste that has been going on for all this time. As the area, however, is entirely uninhabited, and at a long distance from settlement, this waste has hitherto been of less importance than if the area were near commercial centres. It is probable that in the near future, natural gas will play a very important part in the economy of the new provinces of the west and will be the great source of light and heat, as well as of power, for many of the cities of the plains.

It is also to be expected that in certain portions of the plains country, east of the Rocky Mountains, properly located borings will disclose the presence of oil-fields in that area. The oil fields of Colorado, as at Florence and Boulder, are situated on rocks practically of the same horizon, the oil there being found in the Pierre shales, which underlie the lignite-bearing Laramie sandstone. The Florence oil field has been a producer continuously for more than twenty years, several of the wells having yielded enormously. Up to the present time, in the western part of Canada but slight attempts have been made to find oil, with the exception of the borings made under government management some ten to twelve years ago, in the area along the upper North Saskatchewan and Athabaska rivers. At neither of these places, however, did the borings reach the supposed oil-bearing strata, owing largely to the great flow of gas encountered.

Peat.

Peat is found in large quantities in nearly all parts of the Dominion, and about forty years ago attempts were made to utilize certain deposits in Quebec in the manufacture of a peat fuel. As the product was simply pulped and air-dried, without

being consolidated, the results, while giving good results as a fuel both for domestic and railway consumption, were unfitted, owing to its great bulk, for the purposes required. Within the last few years, however, a series of experiments have shewn that peat, properly dried and then compressed, furnishes an excellent fuel for many purposes, and can be made and sold on the market at a good profit, the demand far exceeding the available supply, so that it is anticipated that in a few years, with still further improvements in modes of drying and pressure, this source of mineral fuel will form an important part of Canada's mineral resources.