THE SAGA OF A COALFIELD

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THE memoirs of the Canadian Geological Survey are not now popular reading. Contributions with a geological bias may strike even the more catholic reader as unusual in a university "Review" distinguished by its continuing flow of philosophical, historical and far-sighted political contributions; by reminiscences of men and things in Nova Scotia's past, and by discriminating notices of current *belles lettres* and *Canadiana*. But it was not always so in our sea-girt Province, where Nature's own carving of a disintegrating coast-line reveals to those who love the shore, as Nova Scotians do, new sections of Earth's crust with each recurrent Spring.

In looking over the elder writers of Nova Scotia, Gesner, Haliburton, Dawson, and the more strictly scientific writings of Lyell and Logan in the first half of the nineteenth century, one is impressed by the breadth of their culture, by their almost devotional and aesthetic attitude to the unfolding wonders of what they knew as "natural philosophy"—a most comprehensive term. The tests they had at their disposal were—to our later eyes—meagre and also, to our thinking, inaccurate or half-formed. But these men had something we have lost, or not acquired. They had a sense of wonder. They knew that in their day not the half had been told. The concluding paragraph of the first edition of Dawson's *Acadian Geology*, dated from Pictou in 1855, is an intimate revelation of this attitude of reverent expectancy:

> The discoveries already made show that it has pleased the Great Architect to place in the Acadian provinces many remarkable monuments of His creative work, and to enrich them with no small portion of the "precious things of the earth and of the lasting hills"—and here, as in other lands, those who in an earnest and truth-loving spirit, and in due subordination to their social duties and the higher ends of their spiritual being, engage in the studies of these wonders of the ancient world will not be unrewarded.

Why is it that we, who inherit their labors, who have at our disposal more books than we can read, are not so individual and original in our thinking, have not their avid sense of undiscovered things, have not the humbleness that distinguishes really educated men? We think the gropings of our predecessors towards the truth of things as they are was a childish *naivété*. Might it not

be that it is we who are *naive* because of our intellectual specialization? Perhaps also we make the mistake of thinking that things taught, but not personally discovered, constitute learning. But we must in fairness admit it is no longer possible for individuals, ordinary individuals that is, to compass more than a fraction of the science of our day.

The last twenty-five years have added significantly to geological knowledge of the coal resources of Nova Scotia, and it may not be amiss to condense for general reading, and for Pictonians especially, some quite new conceptions of the origin of the coal deposits of Pictou County, conceptions bearing upon their present economic value.

The story of the coal deposits of Nova Scotia is primarily that of an ancient sea which, something over five hundred million years ago, stretched from what is now New Brunswick to Newfoundland. Gradually, as mountain-building movements raised its floor, this sea retreated, leaving behind the salt beds of Malagash and Nappan, the limestone and gypsums of Windsor and Cape Breton Island. The newly emerged land was mostly waterlogged, dotted with vast swamps and sluggish meandering waterways. The muddy flats of growing river-deltas fringed the emerging shores as the sea retreated ever north-eastward.

> There, where the long street roars, hath been
> The stillness of the central sea.

This was how the Coal Age of Nova Scotia commenced, a preparation through long aeons of geological time on a continental scale of vaster dimensions than the localities where coal-forming swamps later flourished, died, were buried and preserved for our use. Not only were the cosmic beginnings vast relatively to the later accumulation of coal-seams, but the extent of the coal-seams as first laid down very greatly exceeds that which now remains. Probably not half the original deposits remain in the ground, the other half having been removed by constant exposure to wind and weather through 500 million years preceding the coming of Man:

> "Man"—the destined aim and crown
> Of God's prevision. He for whom
> The forests grew, the elder seas
> Flowed in and out, filling Earth's crust
> With treasures, old, yet new.

The unravelling of the record of the deposition of the coal-seams has much more than scientific and academic interest for our work-a-day world. If we can by gradual accumulation of data and applied thinking reconstruct on paper the rough areal outlines of the buried coal swamps in sequence of deposition, we are guided in our search for workable coal-seams. Added to the information gained by actual mining, we are guided in the search for undiscovered coal deposits. We learn not only where to look for coal, but also to know where search would be useless.

Succeeding to the mantle of Lyell, Dawson, Hartley, Logan, Poole, Robb, Fletcher and others who bit by bit through the years developed knowledge of the coal-fields of Nova Scotia, is Dr. Walter A. Bell of the Canadian Geological Survey, a palaeontologist who, over a period of now approaching 25 years, has brought knowledge of the age-relations of the scattered coal-fields of Nova Scotia and New Brunswick to a point of synthesis and understandability that for the first time makes it possible to substitute accuracy for surmise in respect to our coal resources.

Disparate data, knowledge that was purely local, apparent inconsistencies and misconceptions, have now come together in harmonious synthesis. The parts of the puzzle begin to fit, one to the other, and disclose the grand design.

To mortals, whose observance of a changing Earth is limited to so few seasons, and those of struggle for survival, the length of geological time has always seemed unreal, and is not yet universally believed. Yet there is no reason to doubt, and there are very good reasons to believe, that if a sentient being had been present to witness and record changes in Earth's surface, they would not have appeared more frequent or more rapid in duration than Earth changes in our day. It seems probable that the entire duration of historical time may not be as great as the time required for the growth and burial of one thick coal-seam. There are some twenty-five coal-seams in the Sydney Coalfield, and about the same number in the Pictou Field.

The longest-enduring and the last age of coal formation in the Maritimes is grouped by Dr. Bell as "Pictou Age". This period saw the accumulation of the great coal-field lying under the waters of Sydney Harbor and extending with a north-easterly trend for an undetermined distance (probably not less than 25 miles) under the Cabot Strait towards Newfoundland. The smaller and now detached coal-fields at Inverness Mines and at Mabou are of same age, as are the extraordinarily complicated coal-seams of Pictou County.

Partial descriptions of the Sydney coalfield have appeared in this REVIEW[1] in articles dealing with the historical and economic phases of coal-mining, with slight reference to Pictou County. This it is now possible to enlarge, thanks to publication of a Memoir by Dr. Bell on the Pictou coalfield.[2] Some conclusions of wider public interest bearing on the future of this long-mined coalfield are now possible.

Commencing about 1818 and continuing to the present time, a period of 125 years, some 44 million tons of coal have been mined from the Pictou coalfield for sale, while in this period a much larger tonnage has been left in the ground to support the roof or has been made unmineable by mine fires, crushed strata and other concomitants of mining.

With respect to the future of coal-mining in Pictou County as this depends upon the coal remaining unmined, Dr. Bell, who is the person most competent to make the estimate, states:

> On account of the extreme variability both in thickness and quality of the coals of this coalfield within short distances, the writer believes that estimates of reserve tonnages of workable coal would in most instances be so subject to error as to have little value.

It is in itself a revealing comment on the complex structure of the Pictou Coalfield that, after 125 years of mining and accompanying exploration, such an admission of the impracticability of estimating tonnages in the ground should have to be made. Some brief explanation of the reasons for this may be attempted.

The coal-bearing acreage of Pictou County is very small, roughly 11 miles long by 3 miles wide. Some twenty-five recognizable seams of variable thickness and quality are contained in the rocks of this small quadrilateral area. Not only are the coal-seams numerous and of great height or thickness, but the rocks lying in between include highly carbonaceous shale, approaching coally substance and, as elsewhere noted, there are oil-coals and oil-shales in the Stellarton area. The whole stratigraphic column is carbonaceous, gaseous and prone to spontaneous combustion.

There were three separate eras of coal deposition in the Pictou coalfield. The seams mined at Westville were deposited first. These seams are underlain by the soils on which grew the vege-

1. The Future of the Sydney Coalfield and The Colliery Towns, *Dalhousie Review*, July 1941.
Coal Seams and Local History. *Dalhousie Review*.

2. The Pictou Coalfield, Nova Scotia. W. A. Bell, 1940. Memoir of the Geological Survey No. 225.

tation from which they are formed, as shown by the fossilized rootlets they contain. When the Westville deposit had been finally accumulated, it contained some 500 feet of coal-seams, sandstones and shales. Earth movements slowly tilted this assemblage in a northeasterly inclination. During this long drawn-out "warping" of the ground and simultaneously therewith, erosion removed a south-easterly part of the deposit with its contained coal-seams, and new concurrent accumulation of sediments began in the north-easterly depression resulting from the down-warping mentioned, burying still deeper that part of the Westville seams carried downwards and thereby preserved for our use.

Then supervened the accumulation of the Albion seams, one of the most remarkable concentrations of buried vegetation known. At its maximum the deposit consists of some 1,500 feet of strata containing sixteen coal-seams aggregating in total thickness over 270 feet.

In the Albion area, rootlet-bearing ancient soils below the coal-seams are absent. Fossil leaf and tree impressions are rare, such impressions as are found being of isolated torn fronds, a witness to unquiet conditions of deposition. Layers of fish-scales and the remains of small mud-loving shellfish, resembling our shore mussels and limpets, are abundant. All this indicates the origin of the Albion or Stellarton seams as being *drifted* or rafted vegetation, accumulating in scattered lakes joined together by rivers, occupying depressions in a water-logged uneven countryside, subject to intermittent floodings and changes of ground and water levels. There may at times have been inbreaks from arms of the sea causing temporary brackishness.

The peculiarity of "drift" deposits of the Stellarton type is rapid lateral variation of thickness and quality of the coal-beds and shifting thickness of the strata between them. The vegetable *debris* from which the coal is derived seems to have been carried by water and rafted into local "sink-holes". The coal-seams resulting are thickest and best in the centre of the hollow into which the vegetation was floated. On the fringes of the hollows earthy matter mingled with the drifted vegetation, accounting for bands of dirt and high-ash coal as found in mining now. The coal-seams and the strata containing them were therefore accumulated in lenses at different levels. No other coal-field in North America has the "drift origin" characteristics possessed by the Albion-Stellarton coal-seams.

The oil-shales or oil-coal seams found in the Pictou Field

appear to have originated in quiet muddy lagoons of long duration, favoring the growth of shellfish. They were inhabitated by fishes resembling those survivals of our time with bony scales, the pike and sturgeon. These quiet ancient lagoons contained colonies of algae from which came the oil-shales.

Then, in its turn, the Albion-Stellarton accumulation was tilted, the process of burial of the northeasterly portion and the uplifting and erosion of the southeasterly portion—as in the case of the Westville area —being repeated. The earth movements caused heavy fracturing of the rocks, involving once more the buried Westville strata. Again to the northeast there supervened a period of widespread forest-growth and laying down of muds and sands that extended over both the buried Albion-Stellarton rocks, encroaching even upon the still more deeply buried Westville rocks. This time, however, there seems to have followed a more usual type of coal formation, namely growth and burial where they grew of widespread areas of the carboniferous forests. There are rootlets in the coal-seam underclays and a more regular sheet-like bedding of the coal-seams. This last deposition we know as the Thorburn area. It appears to be the remains of forest-swamps extending still further to the north-east, spreading back over the previously deposited Albion-Stellarton and Westville deposits, more or less mantling and covering them up. Once again very severe and complicated earth movements and fractures occurred— including the exposure of the New Glasgow Conglomerate—now showing as the long ridge of Fraser's Mountain. The outcropping edges of the older Albion and still older Westville strata with their contained coal-seams were again nibbled away by millions of years of exposure to wind and weather. Last of all came the most recent Ice Age. The glaciers, while playing only a very minor *rôle* in erosion, left behind a mantle of obscuring rock *debris* that has hidden the coal outcrops and altered the drainage and topography of the whole countryside, adding to the difficulties of observation of the engineer and geologist. The resultant and present condition of the three overlapping areas of coal deposition, which the coal-mines engineer now has to attempt to elucidate and cope with, is of extraordinary complexity. No geologist, however skilled in his lore, could have done very much to resolve this complexity into some order of age of formation unless he had for study the knowledge of the underground structure disclosed by the labors and researches of some five generations of miners. The record they have left of earlier attempts—some successful and some not—

to put together the pieces of this veritable jig-saw puzzle, the logs of hundreds of borings into the strata, both vertical and horizontal, and the great expenditure of capital, all extending over 125 years, have made it possible, for the first time, to tell this story.

One condition, governing the formation of each of the coalfields of Nova Scotia, except the Stellarton seams, may be visualised by anyone who has observed the gradual outward creeping of a sphagnum bog upon its margins spreading ever outwards and encroaching upon the countryside. So it was with the coal-swamps and the sediments that buried them. *The mountains were brought low and the crooked places made straight.* Its economic consequence to our day is that coalseams formed in the beginnings of the swamp are usually smallest in area and poorest in quality. Also it happens that along the spreading margins of the waxing swamp the coal-forming vegetation is most contaminated with earthy matter, while in the centre or heart of the swamp the vegetation accumulated in purest and least contaminated form, resulting in formation of coal of best quality.

Thus in coal-deposits of Nova Scotia type the coal-seams of least area are the most deeply buried and those of widest extent are nearest the surface.

The Stellarton seams, as a consequence of accumulation in deep hollows, are distinguished by quick lateral variations in thickness and quality. The Ford Seam, for example, changes within a short distance from over 30 feet of clean coal to a thickness of over 50 feet of intermingled sheets of coal and shale, finally splitting up and fingering out into barren strata.

The whole Pictou coalfield, as first noted, is of small area. It was more extensively mined at an earlier date than any other Nova Scotia coalfield, the production first exceeding 100,000 tons per year in 1847. Ever since, over nearly a century, the annual production has been larger in proportion to the mineable coal in the ground than in any other provincial coal area.

As has been noted, the persistence of the coal-seams as recognizable seams is much greater than their continuation as seams of workable thickness and marketable quality.

When downward movements of the earth buried one after another the three coal deposits herein mentioned, not only were the thick good-quality central areas of the coal-seams buried and thereby preserved for mining, but also preserved were the thinner marginal areas of coal-seams of inferior quality. Mining at depth therefore eventually runs out of good coal into poorer

coal. Also during the millenniums of geological time throughou which erosion was continuous, not the margins alone but th central areas of thick coal-beds were exposed and carried away

The miner searching for thick coal of good quality naturally attacks the seams where outcroppings show these desirable con ditions, coinciding with a section cut across the cleanest and thickest portions of the original deposit—much as one might slice through the middle of a flat cheese. Mining to depth and sideways in seams entered for mining under these conditions never gets into better coal than where first mined at the "grass roots".

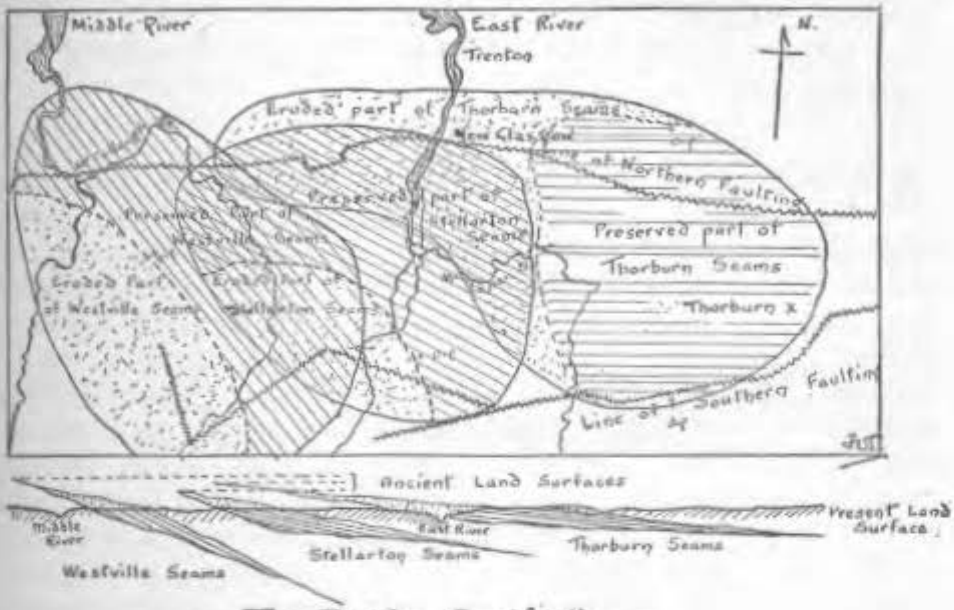
To the eyes of those whose enterprise created the coal-mining industry in Pictou County, the great thickness, the good quality, and easy accessibility of the numerous coal-seams must have been most attractive, although the limited nature of the coal deposits was early recognised.[1]

To the engineers of our day who have inherited a depleted estate and whose greater knowledge of the nature of the coal-deposits has but revealed the enormous difficulties under which future coal-mining must be carried on, the prospect is less alluring.

Such difficulties appeal to the professional pride of mining men. They call for pitting of human ingenuity and courage against natural forces, of ancient origin but present effect, in a fight for livelihood and survival. Every aid of Science should be made use of. In this instance, the problem being essentially geological, the practical help of the geologist is of more than academic worth. It touches intimately the economic welfare of Nova Scotia and that of the people of Pictou County especially.

And if the dry details of coal-mining geology and economics should weary, at least we may still be permitted some meed of that sense of wonder in which the forefathers of Nova Scotia viewed the changing creation we also have inherited.

1. Dawson (See the 1855 edition of *Acadian Geology*), wrote: "Pictou has long been the principal producer of this valuable mineral (coal) in British America. . . Although the thick seams of the Albion mines are not spread over a very extensive area, there is no immediate prospect of their exhaustion, and it is to be hoped that long before this can occur other seams will have been discovered within the district."



—The Pictou Coalfield—
Schematic Plan and Section
(Roughly to Scale)