II.—SOME ANALYSES OF NOVA SCOTIA COALS AND OTHER MINERALS.—BY E. GILPIN, JR., LL. D., F. R. S. C., *Inspector of Mines, Halifax, N. S.*

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I purpose this evening to give you a few analyses of Nova Scotia minerals which are of interest.

A set of analyses of Coals from the three seams worked at Springhill by the Cumberland Railway and Coal Company were given me some months ago. They are as follows, and taken from the workings at a depth of from 800 to 1000 feet:

East or No. 1 Slope—Black or Main Seam:

Moisture	2·02
Volatile combustible matter	18·94
Fixed Carbon	75·29
Ash	3·75
	100·00
Sulphur	1·14

West or No. 2 Slope—South Seam. Sample No. 1, from upper division of seam:

Moisture	1·41
Volatile combustible matter	27·93
Fixed Carbon	67·47
Ash	3·19
	100 00
Sulphur	·58

West or No. 2 Slope—South Seam, lower division of seam:

Moisture	1·51
Volatile combustible matter	28·44
Fixed Carbon	65·38
Ash	4 67
	100·00
Sulphur	·61

North or No. 3 Slope—North Seam:

Moisture	2·71
Volatile combustible matter	28·41
Fixed Carbon	64·69
Ash	4·19
	100·00
Sulphur	·79

Analyst—J. T. DONALD, *Montreal.*

These analyses show the coals to be of excellent quality. The amounts of ash and sulpher are small, and that of the fixed carbon is large.

These analyses are interesting when compared with a set of analyses of the same seams made by me in the year 1881, and I believe not hitherto published, and with an analysis of the Black seam made by me in the year 1880, and published in the Transactions of the North of England Institute of Mining Engineers, in a paper on Canadian Coals, giving a full set of analyses of Nova Scotia coals, their ashes, etc.

The analyses made in the year 1881 are as follows:—

East Slope—Black or Main Seam:

Moisture		3·86
Volatile Combustible Matter,	Fast Coking	35·65
" " "	Slow "	26·46
Fixed Carbon	Fast "	59·90
" "	Slow "	65·23
Ash		4·45
Specific Gravity		1·29
Theoretical Evaporative Power		8.858 lbs.

West Slope—South Seam:—

Moisture		1·399
Volatile Combustible Matter,	Fast Coking	34·808
" " "	Slow "	31·225
Fixed Carbon	Fast "	58·003
" "	Slow "	61·586
Ash		5·790
Sulphur		·808
Theoretical Evaporative Power		8·46 lbs.

North Slope—North Seam :

Moisture	1·625
Volatile Combustible Matter, Fast Coking.	33·401
" " " Slow "	28·672
Fixed Carbon ..Fast "	60·701
" " ...Slow "	65·431
Ash	4·272
Sulphur	·783
Theoretical Evaporative Power	8.99

The analysis of the Black seam made in the year 1878 has a complete sample column of coal representing the whole seam as then worked. A companion column was presented to the museum of the Geological Survey at Ottawa. The section of the seam was as follows :—

	Feet.	Inches.
Top coal, a little coarse	1	7
Coal, good	1	2½
Fire clay parting	—	0½
Coal, good	—	8
Coal, good	1	6
Fire clay parting	—	6
Coal, a little coarse	—	9
Coal, good	—	11
Fire clay parting	—	1
Coal, good	2	2
Coal, good, one inch soft	—	3
Coal, coarse	—	8½
Total	10	4½

I need not repeat here the minute description given then of the various layers. It may be stated that the coal of the sample was bright, with occasional calc-spar and pyrites films, with somewhat irregular fracture. In the vicinity of the point in the mine where the sample was taken a large amount of coal was beautifully iridescent, recalling that splendid mineral Chrysocolla. Samples of this when analysed with the means at my disposal did not give a reason for the coloring. It may have been due to some process of oxidation of iron pyrites.

Each band of caal was analysed with the following results :

Band, No.		1.	2.	3.	4.	5.	6.	7.	8.	9.
Moisture		.98	.76	1 21	.30	.63	.90	1.34	.56	.41
Volatile Comb. Matter	Slow Coking	30.84	32.22	33.81	29.19	28.90	34.56	33.64	30.27	28.54
	Fast Coking	34.75	36 12	37.25	32 65	33.84	35.17	35.94	33.88	30.47
Fixed Carbon	Slow Coking	60.73	60.91	63.13	67.95	65.16	60.59	59.86	60.89	63 63
	Fast Coking	57.82	57.01	59.60	64.48	60.22	59.98	57.56	57.28	61.70
Ash		7 45	6.11	1.85	2.56	5.31	3.95	5.16	8.28	7.42
Sulphur		.85	.56	.79	1.21	1.85	.89	1.40	2.65	2.25
Specific Gravity		1.31	1.30	1.28	1.27	1.29	1.28	1.29	1.33	1.32
Theoretical Evap. Power	Slow Coking	8.33	8.40	8.65	9.28	8.92	8.32	8.20	8.35	8.99
	Fast Coking	7.95	7.65	8.20	8.83	8.30	8.20	7.88	7.75	8.54

Coke bright and tolerably compact.
Ash of average sample grey, with tinge of pink.

The average of the analyses calculating the respective thickness of the bands is about :—

Moisture			·78
Volatile Combustible Matter,	Slow	Coking.	31·32
" " "	Fast	"	33·45
Fixed Carbon	Slow	"	62·54
" "	Fast	"	59.53
Ash			5·34
Sulphur			1·38

The ultimate analyses of the coal gave :—

Carbon	78·51
Hydrogen	5·19
Oxygen / Nitrogen	9·98
Sulphur	1·12
Ash	5·20
	100·00

As compared with the coal from other Provincial districts the Cumberland coals stand as follows :—

	Cape Breton.	Pictou.	Cumberland.
Moisture	·75	1·19	1·86
Volatile Combustible Matter	37·26	29.10	26·76
Fixed Carbon	58·74	60·63	66·65
Ash	3·25	9.34	4·70

From a comparison of the later with the older analyses it will be seen that those of coal from the deeper portions of the seams show lessened amounts of volatile combustible matter, increased percentages of fixed carbon, and diminished amounts of sulphur and ash. Speaking in general terms the coal would appear to have developed more into a steam fuel, the evaporative power being in a general way proportionate to the percentage of fixed carbon.

This would give the coals as at present mined a high calorific power. From analyses by Mason and Matheson in a paper read before the Nova Scotia Mining Society, it would appear that the calorific powers of coals from the Sydney coal fields vary from 7238 to 7623; of Pictou coal (sample from Intercolonial mine) 6963; and of Springhill coal 7898.

As compared with United States coal they should stand nearly in the rank of the best free burning coals of Pennsylvania, Virginia, and Maryland. Those coals hold from 12 to 21 per cent of volatile matter, and from 69 to 76 per cent of fixed carbon. The average contents of the United States coals are from 29 to 35 per cent of volatile matter and from 53 to 67 per cent of fixed carbon. These coals therefore from Springhill should rank for steam purposes next to the class which may be described as the best selected for use on the large ocean passenger vessels.

I have not at hand any proximate analyses of English coals to compare with these under consideration. However, taking the results obtained in the English Admiralty trials of steam coals, and comparing the percentage of fixed carbon found in the trials with the fixed carbon given in these analyses, it will be found that the English and Scotch coals run from 49 to 88 per cent as compared with 68.2 per cent in the Springhill coals.

This would give the Springhill coal about the same relative position to the best Welsh coals as has already been assigned to it in comparison with the best American coals. The evaporative power of the Springhill coals would, from the analyses, stand higher than that of the English and Scotch coals, and rank next to that of the best Welsh steam coals. It may be remarked that the best American and Welsh coals would be classified as free burning, semi-anthracite, while the Springhill coals are bituminous and coking.

I also give here an analysis of the Patrick seam as worked on the Patrick Lease, now the property of the Canada Coals and Railway Company, on the west bank of the Macan River. The sample is from the lower part of the seam :—

Moisture	1·00
Volatile Combustible Matter	55·61
Fixed Carbon	35·60
Ash	7·49
Sulphur	·50

As reddish and pulverulent.

The following analyses of pit waters may be given here :—

Vale Colliery :—

Water contained in 1000 parts.

Sulphate of Lime	·514
" Magnesia	·100
Silicious matter	·190
Chloride of Sodium	1·452
Carbonate of Sodium	7·509
Iron and Alumnina	Trace.
Organic matter	Trace.

No free acid.

Springhill, from feeder 1300 feet level, water clear, free from smell, slightly acid :—

Sulphuric Acid, free	Trace.
Sulphate of Lime	Large.
" Magnesia	Small.
Chloride of Sodium	Considerable.
Carbonic Acid	Small.
Carbonate of Lime	Small.
Iron Oxides	Small.

Water exerted slightly corrosive action on iron exposed to it for twenty-four hours.

A number of analyses of Nova Scotia mineral and pit waters are given in a paper by the writer, read before the Newcastle Mining Institute some years ago.

In the upper part of George's River in Cape Breton County there is a large deposit of iron pyrites in rocks which are, I think, laid down as Laurentian by the Geological Survey. The deposit has as yet been examined only superficially, but so far appears somewhat low in sulphur. The following analysis of samples from the most promising exposure gives :—

Sulphur	25·00
Copper	1·10
Gold	Trace.
Silver	Trace.
Silica	52·00
Iron, etc.	25·00

For a number of years the presence of iron ore at Whycogomah in Cape Breton has been well known. The ores which are magnetites and red hematites are so very favourably situated, being close to the waters of the Bras d'Or Lake, that a good deal of work was done on them a number of years ago. A number of beds were opened and traced. They varied up to nine feet in thickness, and occurred in the Limestone division of the Laurentian, as described by Mr. Fletcher in his numerous reports on the Geology of Cape Breton, issued by the Survey.

The analyses of the ores were contradictory in character, some being high in phosphorus, while others were very pure and ran high in iron. Last fall fresh discoveries were made in this district some distance from the old openings, of beds of magnetite some upwards of 100 feet in width. Indications are not wanting that these ores extend over a large tract of country.

The following analyses will serve to show the quality of the ores :—

Silica	14·41
Alumina	7·33
Manganese Oxide	·61
Lime	3·00
Sulphur	·22
Metallic Iron	54·50
Phosphorus	Trace.
Magnesia	Trace.

Iron.	Phosphorus.	Sulphur.
55·70	None.	·68
59·60	·16	·23
63·20	·004	·31
54·30	·005	·38
53·20	·38	·25
50·74	·31	·024
53·12	·28	·026
52·85	·0058	·138

Silica	21·05
Ferric Oxide	53·54
Ferrous Oxide	21·24
Alumina	2·26
Manganese Oxide	·50
Lime	1·17
Magnesia	·36
Sulphur	·023
Phosphorus	Trace.
Metallic Iron	54.00

Metallic Iron	54·36
Phosphorus	·38

Silica	13·00
Metallic Iron	55·70
Sulphur	·68
Phosphorus	Trace.

These analyses show that there are ores in this vicinity valuable enough for shipment as regards quality, and the present owners consider that new explorations now being carried on will show that the ore is present in quantities sufficient to warrant working on a large scale.

In this connection reference may be made to this division of the Cape Breton Laurentian in which these deposits occur. It may be distinguished as the Limestone division, as it is distinguished mineralogically from the other, or felsite division, by the presence of numerous beds of limestone, in addition to the felsites, gneisses, granites, etc., common to both. These limestones furnish marble, as at West Bay and other localities, lime of excellent quality, and dolomites, suitable, as at New Campbellton, for furnace linings. Iron ores occur in them at numerous points both hematite and magnetite. Graphite is also found In all probability, phosphates, similar to those found in Quebec will be proved on search being made. Where these measures are cut by dykes, copper and lead ores carrying gold and silver occur, and may in some cases prove valuable. As yet so far as my information goes free gold has not been found in quartz in the limestone division. The gold of Middle River and Cheticamp appears to be associated with soft talcose and felsitic schists of the other division. This gold occurs at Middle River free in quartz, and in the river gravel, derived presumably both from the quartz and augmented by gold flakes from the schists. At the Cheticamp River, so far as can be judged from the work done, it would appear to have a similar source, and to be connected only with the felsite series. In the latter case part of the gold may be derived from mineralized zones adjoining the dykes cutting the various rocks. However, the explorations of the coming season will probably give us more exact information. It is interesting to note in connection with the occurrence of gold at Cheticamp that native silver occurs in the Mackenzie River a short distance north, and it is possible that explorations in that section may result in the discovery of important amounts of this metal and associated gold.