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Canada Centre for Mineral and Energy Technology
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REPORT 78–31

COAL ASSOCIATED MATERIALS AS POTENTIAL NON-BAUXITE SOURCES OF ALUMINA

A.A. WINER AND T.E. TIBBETTS

MINERALS RESEARCH PROGRAM
MINERAL SCIENCES LABORATORIES

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

OCTOBER 1978

Available by mail from:

Printing and Publishing
Supply and Services Canada,
Ottawa, Canada K1A 0S9

CANMET
Energy, Mines and Resources Canada,
555 Booth St.,
Ottawa, Canada K1A 0G1

or through your bookseller.

Catalogue No. M38–13/78-31 Price: Canada: $1.25
ISBN 0-660-10217-X Other countries: $1.50

Price subject to change without notice.

En vente par la poste:

Imprimerie et Édition
Approvisionnements et Services Canada,
Ottawa, Canada K1A 0S9

CANMET
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555, rue Booth
Ottawa, Canada K1A 0G1

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Nº de catalogue M38–13/78-31 Prix: Canada: $1.25
ISBN 0-660-10217-X Autres pays: $1.50

Prix sujet à changement sans avis préalable.

COAL ASSOCIATED MATERIALS AS POTENTIAL NON-BAUXITE SOURCES OF ALUMINA

by

A. Winer* and T.E. Tibbetts**

ABSTRACT

An important task in the CANMET project for recovering alumina from non-bauxite sources is the evaluation of alumina-bearing materials. Of potential interest are coal-associated rejects from mining coal washeries and fly ash.

A study of the potential of these materials has shown that coal mine and wash plant rejects from southern Alberta and British Columbia represent a potential source of alumina. The Hat Creek area of British Columbia represents the best potential source of coal-associated alumina both quantitatively and qualitatively. Alumina contents of up to 32% of the ash have been determined in samples from this area. Fly ash from pulverized coal-fired power generating plants in Alberta and possibly from Hat Creek, British Columbia and in Ontario also represent potential sources of alumina-containing material.

Coal-associated shales represents an unknown source. Presently, Alberta and possibly Saskatchewan may have materials of this type which could be of interest. However, sufficient information is not yet available, and exploratory drilling will be required to evaluate their potential.

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LES MATERIAUX ASSOCIES AU CHARBON COMME SOURCE NON-BAUXITIQUE VIRTUELLE D'ALUMINE

par

A. Winer* et T.E. Tibbetts**

RESUME

Un aspect important du projet CANMET sur la récupération de l'alumine de sources non-bauxitiques consiste de l'évaluation des matériaux porteurs d'alumine. Les matériaux associés au charbon, tels que les déchets d'exploitation ou de lavage du charbon provenant des matériaux associés aux couches de charbon et des cendres volantes, peuvent s'avérer intéressants.

Une étude du potentiel de ces matériaux a démontré que les déchets d'exploitation et du lavage en usine du charbon provenant du sud de l'Alberta et de la Columbie-Britannique représentent une source virtuelle d'alumine. La région de Hat Creek en Columbie-Britannique consiste la meilleure source possible d'alumine associée au charbon du point de vue quantitatif aussi bien que qualitatif. Une teneur d'alumine de plus de 32% de la cendre a été determinée dans des échantillons prélevés dans cette région. La cendre volante provenant d'une installation de production par la combustion de charbon pulvérisé en Alberta et tout possiblement de Hat Creek en Colombie-Britannique et en Ontario représente aussi un source virtuelle de matériau contenant de l'alumine.

Les schistes argileux affiliés au charbon sont une source inconnue. En ce moment, l'Alberta et possiblement la Saskatchewan peuvent avoir des matériaux de ce genre qui peuvent être intéressants. Par contre, l'information n'est toujours pas disponible et un forage d'exploration est requis afin d'évaluer son potentiel.

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INTRODUCTION

The objectives of CANMET's "Alumina from Non-Bauxite Sources" project are:

(1) to develop a knowledge base for advising government on policies related to developing alternatives for imported bauxite and alumina;

(2) to make realistic appraisals of potential domestic resources to reduce dependency on imported minerals;

(3) to develop technology to exploit indigenous alumina-bearing material.

Canada's large aluminum industry is completely dependent on imported bauxite and alumina. Policies in some of the principal bauxite-producing countries, moreover, could lead to excessively high prices and/or constrained supply. This has become of concern to Canada and other aluminum- and alumina-producing countries and studies have been initiated into the evaluation of alternative alumina technology in several countries including United States, France, Poland, Russia and Canada.

An important task in the Canadian studies is the evaluation of potential resources including anorthosite, limestone, clays, shales, coal washery rejects, fly ash, and nepheline syenite. A preliminary study has shown that material associated with coal seams of the necessary quality and in sufficient quantity is found mainly in Alberta and British Columbia as well as in other provinces where, however, the quantities are insufficient to support an alumina plant. A satisfactory alumina-bearing source has been empirically determined to contain approximately 25% Al_2O_3.

COAL SEAM ASSOCIATED MATERIAL

Coal-associated material includes mineral deposits interbedded with coal in seams; shales overlying and underlying the coal seam and available as coal mine and washery rejects; and fly ash, a product of combustion. This material has previously been considered as sources for alumina production and in some cases has been studied in the laboratory and pilot plant (1,2,3,11). Such material offers an added advantage as the associated coal could constitute as much as 40% of the reject material which could possibly be used for process heating and calcining. This factor would be an important consideration as the energy savings would be credited against process costs.

The location of coal deposits of Canada is shown in Fig. 1 and 2. Table 1 presents typical alumina analyses of the coal mineral-matter from various areas (4,5,6). Such analyses may also be indicative of the type of mineral contained in the material which is interbedded, overlying and underlying the coal seam. Based on these analyses and this assumption, the areas which most warrant further study would be the Crowsnest coalfield of Alberta and British Columbia and the Pictou County coalfield in Nova Scotia. These areas are promising because of:

(a) a concentration of coal cleaning plants in the Crowsnest area with consequent availability of coal wash rejects and refuse, and

(b) extensive waste banks in the Pictou County coalfield consisting of mine and washery rejects from many years of coal mining.

Table 1 - Alumina content in mineral-matter of coal

Nova Scotia	Al_2O_3 per cent
Bituminous	
Cape Breton Co.	17.3 - 28.5
Inverness Co.	12.3 - 17.3
Cumberland Co.	17.3 - 18.0
Pictou Co.	20.7 - 26.9
New Brunswick	
Bituminous	10.5 - 20.1
Saskatchewan	
Lignite	20.2 - 24.6
Alberta & British Columbia	
Subbituminous	16.8 - 30.0
Bituminous	21.0 - 33.5

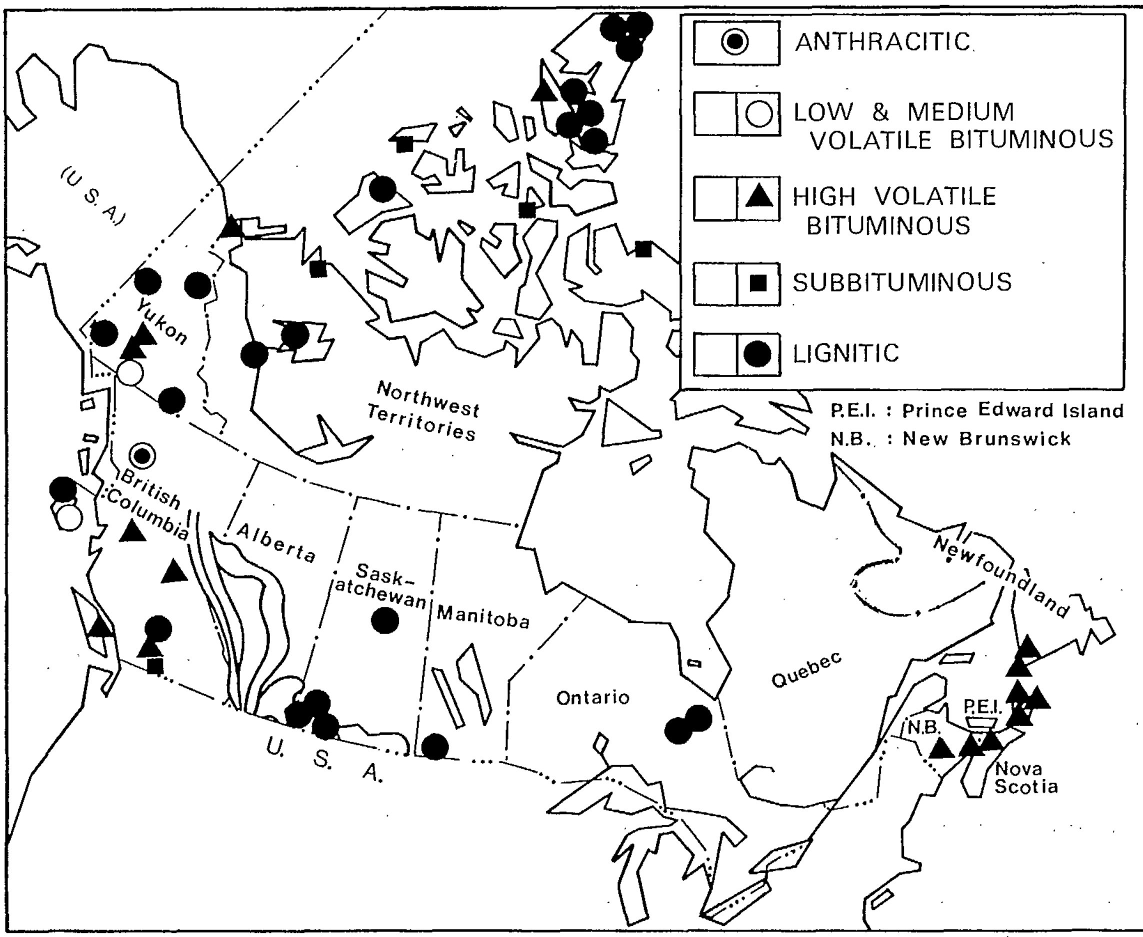

Fig. 1 - Coal deposits and occurrences of Canada by rank

Mineral content of coal, as measured by the ash residue resulting from controlled combustion, is composed of intrinsic and extrinsic parts. The former originated from inorganic salts in the vegetation and from atmospheric sources, whereas the latter is from interbedded shales and clays deposited with vegetation prior to formation of coal. The extrinsic portion is generally more easily removed by mechanical cleaning. The coal adulteration was partly due to mineral salts from percolating solutions and partly due to overlying and underlying shales, clays and other mineral deposits entering the coal during mining operations.

SHALES ASSOCIATED WITH COAL SEAMS, MINING AND WASHERY REJECTS

Shales associated with coal seams and coal mining and washery waste products were examined as potential sources of alumina (Fig 3). Shales penetrated during a coal drilling program

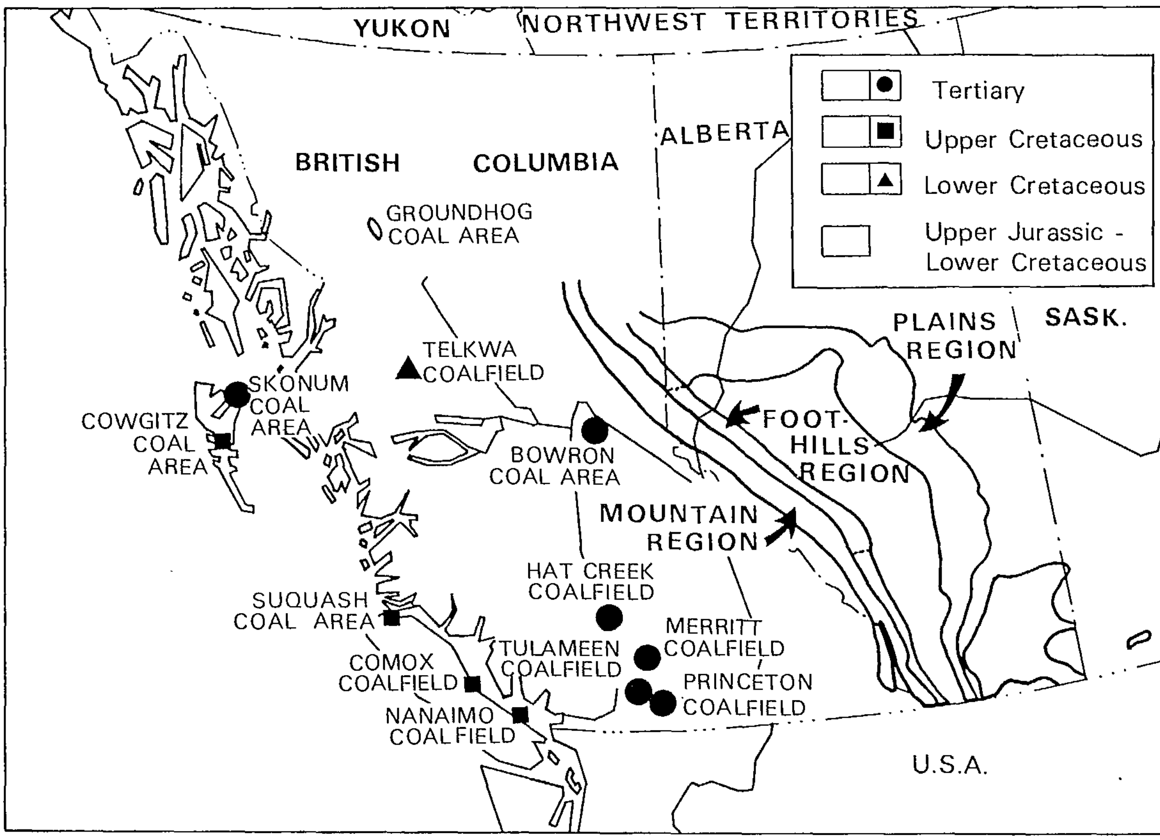

Fig. 2 - Coal deposits of Alberta and British Columbia by age

and samples of mine and washery rejects from selected sites were collected and analyzed for alumina content. The results of these examinations are discussed below by regions.

Nova Scotia and New Brunswick

Nova Scotia has recently been involved in an extensive federal-provincial coal inventory program. Geophysical logs from this program were examined with respect to the penetration of shales overlying coal seams to a maximum depth of 38.1 m (125 ft) and at a 10:1 ratio of overburden to shale. Potentially high alumina-bearing zones were selectd and 17 core samples were taken and analyzed for Al_2O_3 by X-ray fluorescence. Table 2 presents the analyses of the alumina content in these shales.

Analyses of various products from coal washeries in Nova Scotia and New Brunswick are shown in Table 3.

The analyses from these sources are generally not encouraging as the highest alumina content is less than 25% and is associated with an undesirably high iron content.

Analyses of coal mining waste products from several levelled mine sites and waste banks in Nova Scotia are shown in Table 4 (7). The iron content is lower than in the washery rejects

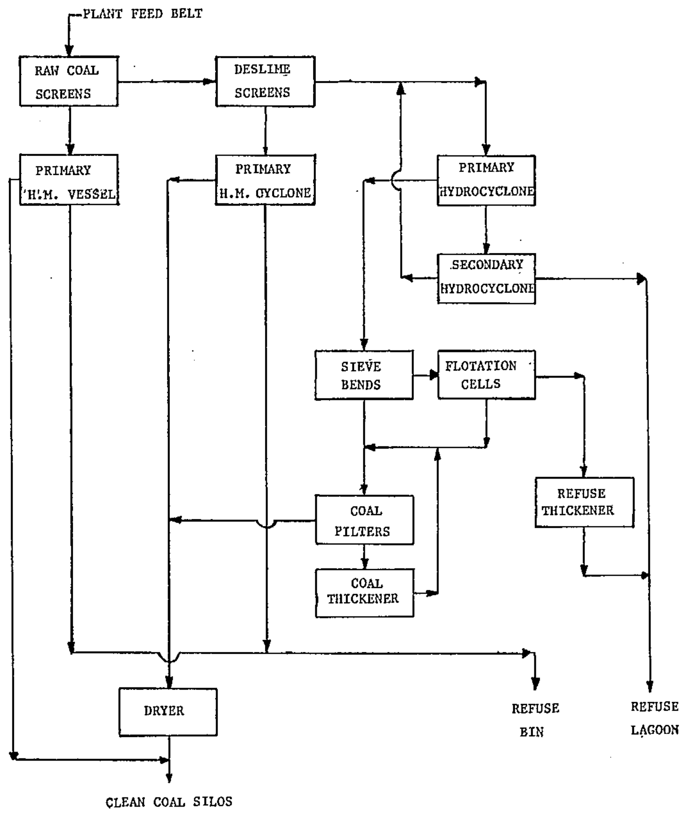

Fig. 3 - A washplant flowsheet

Table 2 - Alumina in shales associated with coal seams in Nova Scotia

Site designated	Sample no.	Depth interval designated	Depth interval represented	Per cent Al_2O_3 in shale
DDNS-P-1	DDNSAL-2	56'00"-66'00"	60'06"-60'08"	21.68
	DDNSAL-3	116'00"-125'00"	120'03"-120'05"	12.95
DDNS-P-2	DDNSAL-4	44'06"-54'05"	49'09"-50'00"	18.45
	DDNSAL-5	66'00"-97'05"	74'09"-75'00"	14.95
	DDNSAL-6	97'05"-102'09"	99'09"-100'00"	14.80
DDNS-P-15	DDNSAL-7	32'10"-46'07"	39'05"-39'09"	19.86
	DDNSAL-8	58'09"-73'03"	60'00"-60'03"	15.33
	DDNSAL-9	75'11"-107'06"	100'00"-100'03"	14.25
DDNS-CC-1	DDNSAL-10	28'03"-63'03"	40'07"-40'09"	8.88
			55'04"-55'06"	17.94
DDNS-CC-4	DDNSAL-11	41'00"-108'00"	60'00"-60'02"	15.21
			80'10"-81'00"	18.24
DDNS-D-1	DDNSAL-12	37'02"-91'11"	50'02"-50'04"	18.35
			74'10"-75'00"	
DDNS-D-5	DDNSAL-13	15'00"-66'02"	25'08"-25'10"	19.70
			50'09"-50'11"	
DDNS-K-1	DDNSAL-14	77'06"-85'00"	79'08"-80'00"	17.44
DDNS-M-4	DDNSAL-15	29'00"-38'04"	29'09"-30'00"	15.21
DDNS-SS-3	DDNSAL-16	25'00"-36'00"	31'04"-31'09"	15.00

Table 3 - Analyses of ash of coal washery rejects from Nova Scotia and New Brunswick

Sample description and source*	Sample 1	2	3	4
	Per cent by weight			
SiO_2	49.22	46.54	29.26	38.12
Al_2O_3	24.75	22.12	9.79	20.77
Fe_2O_3	18.79	17.02	36.10	15.00
TiO_2	1.04	0.90	0.65	0.68
P_2O_5	0.42	0.52	1.85	0.37
CaO	0.56	4.90	5.95	3.26
MgO	1.43	1.06	1.07	1.95
SO_3	0.67	5.12	7.67	3.50
Na_2O	0.40	0.40	0.10	0.11
K_2O	3.06	2.52	1.14	2.47
Al_2O_3 as part of total rejects	9.18	3.74	4.68	9.86

*Sample Description and Source

(1) Reject from secondary screen, Sydney Mines wash plant, Nova Scotia.

(2) Sludge from settling pond, Sydney Mines wash plant, Nova Scotia.

(3) Coal wash plant rejects, Minto, New Brunswick.

(4) Coal wash plant rejects, reclamation project, Stellarton, Nova Scotia.

Table 4 - Analyses of ash of coal mining wastes from Nova Scotia

Sample of description and source*	Sample 1	2	3	4	5	6	7
	Per cent by weight						
SiO_2	42.5	47.3	27.0	34.5	39.2	59.7	31.5
Al_2O_3	18.6	19.3	12.0	9.2	14.7	16.1	20.3
Fe_2O_3	4.40	6.72	6.78	5.50	13.74	6.36	5.42
MgO	0.61	0.81	0.53	0.63	0.58	1.33	0.94
CaO	0.12	0.16	0.67	0.16	0.13	0.24	0.59
Na_2O	0.33	0.37	0.17	0.36	0.47	0.36	0.29
K_2O	2.45	3.36	0.97	2.03	2.57	3.43	3.30
MnO	0.02	0.04	0.05	0.07	0.09	0.22	0.17
TiO_2	0.89	1.00	0.81	0.44	0.73	1.25	1.21
P_2O_5	0.02	0.11	0.12	0.08	0.11	0.12	0.07

*Sample Description and Source

(1) Coaliferous shale, Birch Grove mine site.

(2) Weathered mine wastes from Gardiner mine dump.

(3) Coaliferous shale, Lingan dump.

(4) Coaliferous shale, New Victoria mine site.

(5) Weathered shale from Summit mine dump.

(6) Weathered shale spoil heaps of old No. 7 strip mine.

(7) Waste shale from Pt. Aconi strip operations.

shown in Table 3 and the alumina content of several samples is of definite interest. The quantity of such material was not determined.

Southern Alberta and British Columbia

Samples of rejects from several coal wash plants in southern Alberta and British Columbia were analyzed. As shown in Table 5, except for sample 2, the alumina contents of these samples are of interest.

A projection of the annual volume of wash plant rejects expected by 1985 for all plants combined is approximately 0.907 x 10^6 tonnes (1.0 x 10^6 tons). These rejects are therefore of interest as possible sources of alumina.

Analyses of coal mining wastes from southern Alberta are shown in Table 6. This material contains too little alumina to be considered as a possible source at the present time.

West Central Alberta

One sample of washery reject from a heavy media cyclone was analyzed. The alumina content was 22%, too low to be of interest at the present time.

Subbituminous Coalfields of Alberta

There are no coal washeries in this area. With respect to coal and coal associated shales, two samples from highwalls in the Highvale Mine, west of Edmonton, were analyzed with the results shown in Tables 7 and 8.

Ash from the coal seams in the South Pit is of interest because of the relatively high

Table 5 - Analyses of ash of coal washery rejects from southern Alberta and British Columbia

Sample description and source*	Sample 1	2	3	4	5	6
	Per cent by weight					
SiO_2	62.12	70.32	61.18	66.25	60.67	66.95
Al_2O_3	27.77	17.43	28.53	25.06	28.69	25.00
Fe_2O_3	5.16	5.31	2.27	2.98	3.67	3.03
TiO_2	1.34	0.72	1.20	1.17	1.27	1.35
P_2O_5	0.27	0.56	0.20	0.10	0.25	0.32
CaO	1.04	1.67	3.33	1.35	2.11	2.13
MgO	0.48	1.42	1.09	0.72	0.88	0.76
SO_3	0.01	0.03	0.01	0.02	0.02	0.02
Na_2O	0.06	0.09	0.12	0.12	0.10	0.11
K_2O	0.97	2.17	1.37	1.74	1.31	0.92

*Sample Description and Source

(1) Fine rejects from plant No. 1.
(2) Coarse rejects from plant No. 1.
(3) Fine rejects from plant No. 2.
(4) Coarse rejects from plant No. 2.
(5) Mixed product from plant No. 3.
(6) Flotation tailings from plant No. 4.

Table 6 - Ash analysis of coal mining wastes from southern Alberta

Sample description and source*	Sample 1	Sample 2
	Per cent by weight	
Proximate analysis		
Moisture	6.35	13.48
Ash	63.62	48.44
Volatile matter	10.63	11.61
Fixed carbon	21.16	26.57
Sulphur	0.25	0.24
Ash analysis		
SiO_2	79.11	72.62
Al_2O_3	15.30	21.60
Fe_2O_3	0.80	0.57
TiO_2	0.88	1.25
P_2O_5	0.15	0.16
CaO	0.14	0.22
MgO	0.44	0.53
SO_3	0.05	0.04
Na_2O	0.11	0.09
K_2O	1.45	1.27
Al_2O_3 as part of coal product - per cent	9.73	11.85

*(1) Footwall shale, Crowsnest area, Alberta
(2) Footwall shale, Crowsnest area, Alberta

alumina content of 27 to 29%. In the West Pit, the coal seams as well as the shale immediately below Seams No. 2 and 4 have interesting levels of alumina content (samples W7, W9 and W10).

Hat Creek Coalfield, British Columbia

The Hat Creek coal deposits of British Columbia are approximately 193 Km (120 miles) northeast of Vancouver between Lillooet and Cache Creek. Only minor quantities have been mined in this area over the years but British Columbia Hydro and Power Authority (B.C. Hydro), after acquiring a coal licence in 1974, drilled extensively to delineate a deposit. Because of increased energy prices and the limitations of hydro power development, interest in these deposits has increased. Estimated resources in 1976 were considered to be 460×10^6 tonnes (507×10^6 tons) proved or measured, 572 tonnes (631×10^6 tons) indicated and (1113×10^9 tons) inferred (13).

Hat Creek coal is designated generally as lignitic at approximately 13,956 kJ/kg (6000 Btu/lb) but has a high ash content. Strip mining of this coal is presently contemplated. A task force from the B.C. Hydro has recommended that coal should be the major future energy resource for the generation of electricity in that province. The initial such application will be from

Table 7 - Alumina content in highwall - Highvale mine, south pit

Sample no.	Description	Thickness m	Per cent (dry basis) Ash in sample	Al_2O_3 in ash
1 S	Clay and shale	2.14	92.09	15.13
2 S	Clay and sandstone	1.83	91.12	13.53
3 S	Hard shale,	2.14	94.05	12.36
4 S	shale, and	2.75	94.05	12.45
5 S	sandstone	2.75	94.07	14.60
6 S	Coal (Seam 1)	2.59	23.43	29.10
7 S	Bony coal & shale	0.61	75.48	27.68
8 S	Coal (Seam 2)	2.44	20.57	27.21

Table 8 - Alumina content in highwall - Highvale mine, west pit

Sample no.	Description*	Thickness m	Per cent by weight: Ash in sample	Per cent by weight: Al_2O_3 in ash
W1	Shale	1.53	92.94	17.26
W2	Shale	1.83	84.50	18.10
W3	Coal (Seam 1)	2.75	16.80	25.20
W4	Coal (Seam 1)	3.05	23.82	23.71
W5	Coal (Seam 2)	1.53	22.53	23.93
W6	Coal (Seam 2)	1.53	9.75	27.41
W7	Shale	0.91	81.05	26.21
W8	Coal (Seam 4)	0.76	20.19	16.98
W9 }	Shale	1.53	67.47	26.19
W10 }			66.56	27.08

*Shale between W4 and W5 (Seams 1 and 2) not sampled.
Shale and coal (Seam 3) between W6 (Seam 2) and W7 not sampled.

the Hat Creek deposits some 113 km (70 miles) west of Kamloops on lands owned by B.C. Hydro. The Hat Creek thermal project, as recommended, will progress in two phases. The first calls for four 500-MW generating units to be on line between 1983 and 1985, with the second phase to consist of four 700-MW units to be in service between 1986 and 1988.

Coal washing plants have not been included in B.C. Hydro proposals, but provision has been made with CANMET to do some coal washing tests. Although B.C. Hydro plans to burn Hat Creek coal in conventional type coal combustion furnaces, low temperature controlled combustion experiments are being made in a CANMET pilot plant. Provision has been made to study samples of the Hat Creek coal and wash-test rejects in this pilot plant.

Ash produced by low-temperature controlled combustion experiments did not appear to be sintered. Initial experiments at approximately 790°C were promising and more trials will be made at both higher and lower temperatures. Acid leaching experiments are also being made to determine the alumina extraction efficiency. Ash analyses of various samples of Hat Creek coal submitted to CANMET's Energy Research Laboratories are shown in Table 9.

The alumina content of the coal ash is generally high and the iron appears to be partially amenable to separation by electrostatic means. Some preliminary experiments at CANMET have confirmed that at least some of the iron is magnetic. The Hat Creek coal deposits appear to be an excellent potential source of alumina on the basis of current studies.

Saskatchewan

A federal-provincial coal drilling program in the Ravenscrag Formation of southern Saskatchewan, including the Estevan, Willow Bunch, Wood Mountain and Shaunavon areas, has just been completed. Shales were penetrated, but although analyses are not yet complete, indications are that alumina content is not high.

There are no coal washeries in Saskatchewan.

Manitoba

Coal or coal-associated shales in Manitoba were not evaluated as these resources are not significant.

Table 9 - Raw and washed coals from Hat Creek*

Sample No. and description	Ash analyses - per cent by weight											Weight per cent in coal	
	SiO_2	Al_2O_3	Fe_2O	Mn_3O_4	TiO_2	P_2O_5	CaO	MgO	SO_3	NaO_2	K_2O	Al_2O_3	Ash
2.1 A Raw	56.18	28.26	6.69	0.30	0.89	0.13	1.23	1.34	0.97	0.47	0.94	14.76	52.08
2.2 A Raw	56.94	31.38	7.53	0.03	1.31	0.12	1.51	1.17	1.10	0.47	0.79	14.87	47.39
3.1 A Washed	53.57	28.76	8.68	0.02	1.63	0.20	2.57	1.34	1.77	0.56	0.73	8.71	30.27
3.2 A Washed	55.63	30.13	8.01	0.02	1.70	0.19	2.53	1.04	2.12	0.54	0.74	8.96	29.75
4.1 B Raw	48.24	29.14	11.11	0.13	1.18	0.37	3.82	1.10	3.62	0.28	0.37	10.91	37.43
4.2 B Raw	50.85	29.84	9.36	0.12	1.31	0.37	4.11	0.94	3.17	0.31	0.36	9.20	30.84
4.3 B Raw	50.82	30.53	8.43	0.10	0.10	1.29	0.35	4.06	1.59	3.31	0.33	8.79	28.80
5.1 B Washed	48.28	31.41	6.80	0.06	1.42	0.38	4.54	1.30	2.70	0.29	0.37	7.48	23.81
5.2 B Washed	48.42	31.07	6.61	0.07	1.45	0.37	4.47	1.64	3.12	0.29	0.35	6.81	21.91
5.3 B Washed	49.43	31.85	6.57	0.06	1.52	0.41	4.66	1.51	3.00	0.31	0.36	6.59	20.68
6.1 C Raw	49.98	32.10	7.89	0.16	1.30	0.18	2.59	1.43	1.37	0.50	0.47	9.09	28.32
6.2 C Raw	51.20	29.06	6.78	0.10	1.10	0.16	2.81	1.20	2.67	0.54	0.60	7.51	25.84
6.3 C Raw	51.22	29.00	6.84	0.09	1.03	0.14	2.33	1.39	2.87	0.48	0.59	8.76	30.20
7.1 C Washed	50.61	29.57	5.28	0.07	1.26	0.27	3.48	1.50	3.66	0.60	0.58	5.64	10.09
7.2 C Washed	51.23	30.19	5.11	-	1.26	0.36	3.64	1.44	2.96	0.64	0.63	5.48	18.16
7.3 C Washed	50.20	28.66	6.88	-	1.24	0.43	3.63	1.81	2.98	0.67	0.63	5.44	19.00

*Wash tests and analyses by CANMET.

Ontario

There are no coal mine or wash plant rejects in Ontario. Lignite deposits in northern Ontario, at Onakawana, have not yet been exploited.

FLY ASH

Ash Properties

Fly ash is a potential source of alumina (8-12). It is usually recovered from the stack gases of coal-fired electric power generating stations by electrostatic and mechanical collectors.

Table 10 shows the difference in particle size of fly ashes mechanically collected and those electrostatically precipitated. Fly ash is variable in its properties from one source to another depending on the coal used and the method of operation of the plant.

Chemical analyses of fly ashes from several power generating stations in Canada are shown in Table 11. Their relatively low alumina content reduces the significance of fly ash as a potential source from these areas.

Ash Quantities

Maritime Provinces

From available information as shown in Table 12, it has been estimated that present and projected quantities of fly ash in the Maritime Provinces, even by 1980, will not be sufficient to be considered as an alumina resource (9).

Ontario

Forecasts indicate that about 0.68 x 10^6 tonnes (0.75 x 10^6 tons) of fly ash will be generated per year by 1979 (Table 13), rising to 1.1 x 10^6 tonnes (1.2 x 10^6 tons) by 1983 (9). This will be derived mainly from coal imported from the U.S.A. However, by 1978, up to 2.7 x 10^6 tonnes (3.0 x 10^6 tons) of Western Canadian high bituminous coal may be used. In addition, 1.2 x 10^6 tonnes (1.3 x 10^6 tons) of lignite from Western Canada will be required by 1981 (13).

Saskatchewan

Even by 1980, present forecasts of fly ash production at 227,000 tonnes (250,000 tons),

Table 10 - Particle size analyses of two fly ashes (8)

Size (μm)	Cumulative per cent (by weight) undersize	
	Mechanically collected ash	Electrostatically precipitated ash
2380	100.0	-
1190	99.9	-
590	99.5	100.0
297	98.8	99.4
149	97.5	98.0
74	88.0	93.7
60	81.6	91.3
45	72.3	87.7
38	68.2	85.4
30	57.9	80.2
23	51.4	79.0
15	48.7	78.3
10	37.6	76.0
5	16.9	67.0
3	7.3	55.6
1.5	2.7	32.7

Table 11 - Analysis of fly ash from coal-fired generating stations in selected regions

Coal type used	Region	Ash analysis - per cent by weight									
		SiO_2	Al_2O_3	Fe_2O_3	TiO_2	P_2O_5	CaO	MgO	SO_3	Na_2O	K_2O
Bituminous	Nova Scotia										
	- Sydney	27.98	18.95	40.78	0.59	0.39	3.29	1.59	3.96	0.48	1.10
	- Maccan	39.28	18.03	31.65	0.89	1.31	8.43	2.35	1.33	0.48	3.59
	- Trenton	36.76	18.86	30.83	0.95	0.63	1.93	0.73	0.82	0.39	2.53
	New Brunswick										
	- Minto (Grand Lake)	28.53	12.23	50.42	0.60	1.24	2.80	0.00	2.33	0.48	0.66
Sub-bituminous	Alberta										
	- Edmonton area (Wabamun)	47.41	22.93	4.48	0.46	0.86	12.74	2.43	6.34	0.58	0.44
	- Forrestburg area (Sundance)	29.08	22.78	5.56	0.37	1.59	19.25	1.76	11.61	7.65	0.37
Lignite	Saskatchewan										
	- Estevan area (Boundary Dam)	36.97	21.34	3.36	1.00	0.24	16.10	3.73	8.01	6.98	0.44
Imported Bituminous	Ontario	43.6	18.0	15.0	3.4	-	3.4	0.9	1.4	1.4	2.4

Table 12 - Availability of fly ash in Nova Scotia and New Brunswick

Utility	Station*	Reported and projected fly ash quantities metric tons per year						Information source
		1973	1976	1977	1978	1979	1980	
Nova Scotia								
Nova Scotia Power Corporation	Glace Bay	10,884	10,884	--	--	--	--	(A)
	Trenton	--	--	33,559	--	--	--	(A)
	Lingan**	--	--	--	--	45,400	45,000	
New Brunswick								
New Brunswick Electric Power Commission	Grand Lake	31,745	31,745	31,745	31,745	76,188	76,188	(B)

*From reference (9)

(A) Nova Scotia Power Corporation

(B) New Brunswick Electric Power Commission

**New station to open in 1979 with a second unit scheduled for late 1980. Fly ash to increase to 90,700 tonnes/y by 1981.

Table 13 - Availability of fly ash in Ontario (9)

Utility	Station	Reported and projected fly ash quantities metric tons per year	
		1975	1979
Ontario Hydro	R.L. Hearn (Toronto)	23,600	23,600
	I.C. Keith (Windsor)	3,628	8,163
	Thunder Bay	10,884	25,396
	Lakeview (Toronto)	274,821	405,429
	Lambton	230,378	326,520
	Nanticoke	362,800	686,599

will not be sufficient to warrant further investigation (Table 14).

Alberta

Fly ash production of up to 907,000 tonnes (1.0×10^6 tons) annually by 1980, has been forecast for plants in Alberta, and so should be considered a potential alumina source.

British Columbia

There are at present no electric generating stations in British Columbia using Hat Creek coal and no fly ash has been produced, except experimentally. If present plans to use conventional pulverized-coal combustion units are accepted, then the following calculation can be made.

A 2000-MW plant would burn about 36,280 tonnes (40,000 tons) of coal per day. Assuming ash content at 28%, it is expected that about 7710 tonnes (8500 tons) of fly ash per day would pass up the flue. The proposed development (13) in 1983 and 1984 of four 500-MW electric power plants would require about 10.9×10^6 tonnes

Table 14 - Availability of fly ash in Manitoba, Saskatchewan and Alberta

Utility	Station*	Reported and projected fly ash quantities metric tons per year				Information source
		1975	1976	1977	1980	
Manitoba						
Manitoba Hydro	Selkirk	4,988	--	--	--	(A)
	Brandon					
Saskatchewan						
Saskatchewan Power Corporation	Estevan	136,050	136,050	226,750	226,750	(B)
	Boundary Dam					
	Queen Elizabeth	4535-9070	--	--	--	
Alberta						
Alberta Power Corporation	Drumheller	68,025	No data available			(C)
	Battle River		113,375	113,375	226,750	
	H.R. Milner	90,000 (approx.)	--	--	--	
Calgary Power Corporation	Wabamun	--	272,100	--	--	(D)
	Sundance	--	272,100	544,200	907,000	

*From reference (9)

(A) Manitoba Hydro

(B) Saskatchewan Power Corporation

(C) Consolidated Concrete Ltd. and Alberta Power Corporation

(D) Western Fly Ash Ltd. and Calgary Power Corporation

(12×10^6 tons) of coal per annum. Also proposed is an increase in power generation up to 2800 MW. However, if the conservative estimates of 2000 MW is assumed, 7710 tonnes (8500 tons) of fly ash per day could be produced. Assuming an operation of 300 days per year allowing for interruptions, more than 2.27×10^6 tonnes (2.5×10^6 tons) of fly ash containing 28 to 32% alumina would be produced annually. Preliminary experiments have shown that Fe_2O_3 in the ash can be reduced electrostatically. It would thus appear that Hat Creek fly ash should be considered as a significant source of alumina when and if it becomes available. This source material must undergo further research, including technical and economic feasibility studies.

CONCLUSIONS

The following conclusions were based on the foregoing study:

(1) Coal mine and wash plant rejects from southern Alberta and British Columbia represent a potential source of alumina.

(2) The Hat Creek deposits represent the best potential source of coal-associated alumina both quantitatively and qualitatively. An alumina content of up to 32% of the ash has been determined in samples from this area. Acid processing techniques for extracting alumina would probably be used.

(3) Fly ash from Alberta and Ontario and possibly projected additional quantities from Hat

Creek, also represent potential sources. Sinter processing techniques, which are generally more expensive, would be required with these sources.

(4) Coal-associated shales located in Alberta and possibly in Saskatchewan represent an unknown source requiring exploratory drilling.

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