CANMET

Canada Centre for Mineral and Energy Technology

Centre canadien de la technologie des minéraux et de l'énergie

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MINERAL WASTE RESOURCES OF CANADA REPORT NO. 4 – MINING WASTES IN THE ATLANTIC PROVINCES

R.K. COLLINGS

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MINERAL WASTE RESOURCES OF CANADA
REPORT NO. 4 - MINING WASTES IN THE ATLANTIC PROVINCES*

by

R.K. Collings**

SYNOPSIS

Legislation restricting mining in many urban centres, exhaustion of ore deposits, and increased cost of locating and developing new orebodies have combined to focus attention on mineral waste accumulations as possible supplemental sources of mineral raw material. Current annual production of such wastes by the mining industry of Canada is about 800 x 10^6 t. Only a small portion of this is used because of remote location and low quality, as well as a lack of detailed information on the nature of these wastes and their possible uses. Current applications include road construction and maintenance, railroad ballast, smelter flux, and mine backfill. Uses being studied by CANMET researchers include the recovery of contained metals and minerals, the production of concrete and construction aggregate, the manufacture of bricks, building blocks and mineral wool insulation, and use as a mineral filler and soil additive.

This report provides background information on waste rock and mill tailings in the Atlantic Provinces where more than 45 x 10^6 t of such wastes are produced annually. Data on the occurrence, mineralogy, petrography, and physical and chemical characteristics of wastes from 17 operating mines are provided in tabular form for three principal types of mines - metal, non-metallic or industrial mineral, and coal. Potential uses for these wastes are noted along with relevant research.

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*Project MRP-4.3.5.0.02 - Identification, Characterization, Evaluation of Primary Mineral Wastes, and **Head, Non-Metallic and Waste Minerals Section, Mineral Sciences Laboratories, CANMET, Energy, Mines and Resources Canada, Ottawa.

RESSOURCES CANADIENNES EN REBUTS MINERAUX
RAPPORT NO. 4 - LES REBUTS MINERAUX DANS LES PROVINCES ATLANTIQUES*

par

R.K. Collings**

RESUME

Les lois qui restreignent l'exploitation minière dans de nombreux centres urbains, l'épuisement des gisements de minerai, la hausse des coûts de la découverte et de la mise en valeur des nouveaux gisements de minerai ont tous contribué à attirer notre attention sur la possibilité d'utiliser les minéraux résiduels à titre de sources supplémentaires de minéraux bruts. La production annuelle courante de déchets dans l'industrie minière du Canada est de l'ordre de 800 x 10^6 t. Cependant, l'industrie n'en utilise qu'une petite quantité en raison de certains facteurs comme l'éloignement des dépôts, leur faible teneur en minerai pur ou à cause du manque d'information concernant leur nature ou leurs usages éventuels. On s'en sert présentement pour la construction et l'entretien des routes ou comme ballast, comme fondant dans les fonderies et comme matériau de remblayage dans les mines. Les chercheurs de CANMET et ceux des autres organismes étudient la possibilité d'utiliser les déchets à d'autres fins, dont la récupération du métal et des minéraux qu'ils contiennent, la production de béton et d'agrégats destinés au secteur de la construction, la fabrication de briques, de blocs et d'isolants en laine minérale, l'utilisation comme matériaux de remplissage minéral ainsi que la préparation d'amendements ou de neutralisants pour les sols.

Ce rapport fournit des données de base sur les roches résiduelles et les résidus d'établissement de broyage dans les provinces Atlantiques dont la production annuelle s'élève à environ 45 x 10^6 t. Les données concernant l'abondance, la minéralogie et les propriétés physiques et chimiques des déchets des dix-sept mines en exploitation sont disposées en tableaux pour les trois principaux types de mine: métaux, minéraux non-métalliques ou industriels et charbon. Les usages possibles de ces déchets et la recherche pertinente sont mentionnés.

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*Project MRP-4.3.5.0.02 - Identification, caractérisation et évaluation des minéraux résiduels primaires, et **Chef, Section du traitment des minéraux non-métalliques et résiduels, Laboratoires des sciences minérales, CANMET, Energie, Mines et Ressources Canada, Ottawa.

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INTRODUCTION

Canada has large resources of most metallic and non-metallic minerals. These are non-renewable and many higher-grade deposits are steadily being depleted as the mining industry strives to satisfy an ever-increasing demand for minerals and metals. To meet current and projected requirements for metals, mining companies are finding they must search far afield, sometimes in remote areas, for new orebodies. Similarly, exhaustion of favourably located reserves of industrial minerals and legislation restricting mining near urban centres are forcing operators to look for and to develop more distant deposits. The net result is increased costs at all stages, from initial exploration through to the shipment of processed ore or mineral concentrates to markets. These factors have stimulated research into the technical and economic feasibility of recovering minerals and metals from lower-grade but often more accessible deposits, including mining wastes. This report is concerned with such wastes in the Atlantic Provinces.

Mining wastes are being generated and accumulated at a rate in excess of 800×10^6 t/a in Canada. The Atlantic Provinces account for about 45×10^6 t. Such wastes normally have been of little interest and, in fact, represent additional expense in that they are costly to treat and to maintain in dumps and tailing ponds. Some, however, are now being examined more closely. Environmentalists, on the one hand, are concerned with pollution hazards with respect to air and water, whereas mining companies and other resource-oriented groups are becoming increasingly interested in the possibility of recovering additional metals and minerals, e.g., copper, gold, silver and other metals, from tailings at abandoned mines, of using wastes as raw material for manufacturing various products, e.g., bricks and building blocks, and in other applications such as soil additives and as mineral fillers in various products.

Current interest in mineral wastes has resulted in an increased need for information on their physical and chemical natures. The Canada Centre for Mineral and Energy Technology (CANMET) is engaged in a study of mineral wastes which has three major objectives:

- to identify their nature and magnitude
- to investigate the technical and economic feasibility of recovering contained minerals and metals and of using wastes for various products
- to encourage further research by industry and government.

As part of this study, technical data on Canada's vast and growing mineral waste resources have been systematically documented. Reports on mining wastes have been published for Ontario, Quebec and British Columbia (1,2,3). The Quebec report is also available in French (4). This present report on the Altantic Provinces will be followed in 1981 by one on the Prairie Provinces, the fifth in this series. These reports are all concerned with operating mines. However, wastes from abandoned mines and from metallurgical and chemical operations are also of interest and will be documented in future reports.

MINERAL WASTES

Mineral wastes are divided into four general groups in Table 1. Those in the first two groups are large-volume, low-grade mixtures of minerals and as such are usually unattractive for further economic exploitation. Overburden material can be used for roads or as landfill, and waste rock may be useful as railroad ballast and as concrete and construction aggregate. However, in most instances, the problem of disposal is best solved by long-term stabilization and landscaping. Rehabilitation may greatly increase the value of disposal areas as building sites or as recreational parks.

The last two groups include wastes which have been partially processed and are often uniform in character and grain size. These wastes may contain significant amounts of metals and minerals that may be recoverable or they could be potential sources of raw materials for use as construction materials, in ceramic products, and in various other applications. The mining wastes considered in this report, i.e., waste rock and mill tailings, belong to Groups 2 and 3, respectively, of Table 1.

Table 1 - Classification of solid mineral wastes

	Group and type			
	1. Overburden	2. Gangue or waste rock	3. Mine and mill tailings	4. Metallurgical, chemical and pulp and paper residues
Description	Soil, sand, clay shale, gravel, boulders, etc.	Rock which must be broken and removed to obtain ore; many types, e.g., limestone, granitic and volcanic rocks	Rock minerals, usually sand to slime sizes but sometimes larger; may include sulphides	Slags, fly ash, cinders, dust, slimes, sludges, etc.
Characteristics	Heterogeneous and unconsolidated	Broken rock, usually homogeneous, but varying widely in size	Usually uniform in character and size	Usually uniform in character and size; sometimes toxic
Examples	Cover removed from open pit coal, gypsum, and some iron mines	Broken rock from open pits, e.g., iron mines	Tailings from many diverse operations, e.g., base, ferrous and precious metal processing, and non-metallic mineral operations	Slags from iron and steel plants, fly ash from power plants, salt from potash recovery operations, gypsum from phosphate fertilizer plants
Nature of problem and potential use	Materials handling and storage; little intrinsic value but may be useful as fill, railroad ballast, and in landscaping; waste rock may have value as construction aggregate, e.g., in concrete and asphalt mixes		Materials handling and storage; may compete for valuable land space; unsightly and possible source of air and water pollutants; potential source of metals and minerals and raw material for the manufacture of bricks, blocks, soil fertilizers and additives, mineral fillers, chemicals, etc.	

MINING WASTES IN THE ATLANTIC PROVINCES

Information on mining wastes in the Atlantic Provinces is presented in Tables 2 to 8. These list the main operating mines, provide brief descriptions of the types of operation, geology and ore mineralogy, and describe the mineral wastes produced. Tonnage estimates and current and potential uses are noted. In addition, chemical and mineralogical data are given for a number of samples of mill tailings. Sand and gravel pits, gypsum mines, and dimension stone and crushed stone quarries have not been included although waste fines and coarse material may be available for reuse at these operations. As a further aid to appraisal, wastes are separated into four general categories based on origin as follows:

Base metal operations	(Table 3)
Iron ore operations	(Table 4)
Industrial mineral operations	(Table 5)
Coal operations	(Table 6)

Table 2 - Company, location, and identification number*

Company, location	Identification number
Base metal operations	
ASARCO Incorporated, Buchans Unit, Buchans, Nfld.	1
Consolidated Rambler Mines Limited, Baie Verte, Nfld.	2
Newfoundland Zinc Mines Ltd., Daniel's Harbour, Nfld.	3
Brunswick Mining and Smelting Corporation Limited, Bathurst, N.B.	4
Consolidated Durham Mines and Resources Ltd., Lake George, N.B.	5
Heath Steele Mines Ltd., Newcastle, N.B.	6
Iron ore operations	
Iron Ore Company of Canada, Carol Division, Carol Lake, Lab.	7
Wabush Mines, Wabash, Lab.	8
Industrial mineral operations	
Advocate Mines Ltd., Baie Verte, Nfld.	9
Aluminum Co. of Canada Limited (Newfoundland Fluorspar Works), St. Lawrence, Nfld.	10
The Canadian Salt Company Limited, Pugwash, N.S.	11
Coal operations	
Cape Breton Development Corporation, Lingan colliery, New Waterford, N.S.	12
Cape Breton Development Corporation, Prince colliery, Point Aconi, N.S.	13
Cape Breton Development Corporation, No. 26 colliery, Glace Bay, N.S.	14
Cape Breton Development Corporation, Victoria Junction plant, Sydney, N.S.	15
Cape Breton Development Corporation, Sydney Mines plant, Sydney Mines, N.S.	16
River Hebert Coal Company Limited, River Hebert, N.S.	17
Thorburn Mining Limited, Stellarton, N.S.	18
N.B. Coal Limited, Minto, N.S.	19

*The location of operations and waste samples from these operations are identified by corresponding numbers on the map, Fig. 1, and in Tables 2 to 8.

Table 3 - Mineral wastes, base metal operations

Company mine/mill location*	Type of operation, geology and ore mineralogy	Mineral wastes		
		Item	Rock	Mill tailings
1. ASARCO Incorporated Buchans Unit, Buchans, Nfld.	Underground mine - copper, zinc, lead	Amount**	4000 t/a mine develop 85 000 t/a sand pit	Substantial (160 000 t/a)
	Mill capacity - 1100 t/d; crushing, grinding, sizing flotation	Size, pH Relative density	95% plus 15 mm	90% minus 150 µm 8.2 3.3
	Massive sulphide orebody in basic volcanic tuff and breccia; ore and associated minerals include sphalerite, galena, pyrite, chalcopyrite with minor bornite and hematite; some gold and silver	Constituents**	Mine rock - dacite Sand rejects - quartz	P.C. - barite, quartz, mica M.C. - pyrite ($BaSO_4$ 30 to 35%, SiO_2 30%, Cu 0.13%, Pb 0.24%, Zn 1.2%, Fe 4.3%)
		Current or potential use	Rock dump disposal	Tailings pond disposal; tailings contain an estimated 500 000 t of barite; recovery of barite has been investigated by CANMET and others (9); current study by company of recovery of barite for use in oil-well drilling (8)

* Locations shown in Fig. 1.

** Amount accumulated: large $> 10 \times 10^6$ t

substantial 1 to 10×10^6 t

small $< 1 \times 10^6$ t

annual rate of accumulation shown in brackets

2. Consolidated Rambler Mines Limited, Baie Verte, Nfld.	Underground mine - copper, gold, silver	Amount**	Small	Substantial (200 000 t/a)
	Mill capacity - 1200 t/d; crushing, grinding, sizing, flotation, dewatering	Size	Minus 150 mm	70% minus 75 µm
		pH		5.8
		Relative density		3.6
	Ore zone occurs in acid volcanic schists; ore and associated minerals include chalcopyrite and pyrite	Constituents***	Quartz, sericite, chlorite schist, basic dike rock	P.C. - pyrite, quartz M.C. - plagioclase
		Current or potential use	Current use in road construction and in tailings pond dikes	Tailings pond disposal
3. Newfoundland Zinc Mines Ltd., Daniel's Harbour, Nfld.	Underground/open pit mines - zinc	Amount**	Nil	400 000 t/a
	Mill capacity - 1360 t/d; crushing, grinding, sizing, flotation	Size		25% minus 75 µm
		pH		8.7
		Relative density		2.9
	Stratiform sphalerite ore-bodies in bedded Ordivician dolomite	Constituents***		P.C. - dolomite M.C. - quartz, calcite
		Current or potential use		Tailings are being used experimentally as soil additive to reduce acidity

***P.C. - principal constituents, > 10%

M.C. - minor constituents, < 10%

Table 3 (cont'd)

Company mine/mill location*	Type of operation, geology and ore mineralogy	Mineral wastes		
		Item	Rock	Mill tailings
4. Brunswick Mining and Smelting Corporation Limited, Bathurst, N.B.	Underground mine, No. 12, and open pit, No. 6 - zinc, lead, copper	Amount**	265 000 t/a (No. 12) 10 000 t/a (No. 6)	Large (32 x 10^6 t)
	Mill capacity No. 12 - 5760 t/d; No. 6 - 3175 t/d; crushing, grinding, sizing, flotation	Size pH Relative density	Minus 150 mm	85% minus 40 µm 6.4 3.9
	Ore and associated minerals include pyrite, sphalerite, galena, chalcopyrite and pyrrhotite in quartz porphyry and tuffs	Constituents***	Argillite, quartz-eye schist, crystal tuff iron formation	P.C. - pyrite, silicates, (38% S, 33% Fe, 10% SiO_2) M.C. - pyrrhotite, carbonates (1.0% Pb, 1.7% Zn, 0.15% Cu, 1.0 oz/t Ag)
		Current or potential use	All waste rock is used as backfill in cut and fill stopes	Tailings pond disposal; potential source of iron, sulphur and silver
5. Consolidated Durham Mines Limited, Prince William, N.B.	Underground mine-antimony	Amount**	Nil	1 x 10^6 t (30 000 t/a)
	Mill capacity - 360 t/d; crushing, grinding, sizing, flotation	Size pH Relative density		55% minus 75 µm 8.5 2.8
	Fracture-filled, quartz vein deposit; main ore mineral is stibnite with minor amounts of native antimony and senarmontite; host rock is Silurian grey-wacke	Constituents***		P.C. - quartz M.C. - mica, kaolinite
		Current or potential use		Tailings pond disposal; potential uses include sand blasting and foundry moulding sand

6. Heath Steele Mines Ltd., Newcastle, N.B.	Underground mine - zinc, lead, copper, silver	Amount**	Minor (90 000 t/a).	Small (740 000 t/a)
	Mill capacity - 4000 t/d; crushing, grinding, sizing flotation	Size pH Relative density	Minus 0.5 m	75% minus 45 μm 5.9 4.1
	Ore and associated minerals include chalcopyrite, pyrite, sphalerite and galena in quartz-feldspar schists, chloritic tuffs, and sediments	Constituents***		P.C. - pyrite (57%), pyrrhotite (16%), (38% Fe, 37% S, 13% insol.) M.C. - carbonates, quartz, plagioclase, magnetite, (1.28% Zn, 0.17% Pb, 0.33% Cu, 0.91 oz/t Ag, 0.013 oz/t Au)
		Current or potential use	Currently used as mine fill.	Tailings pond disposal; potential uses include production of sulphuric acid and recovery of contained metals; useful also as a fuel in roasting/ smelting operations

Table 4 - Mineral wastes, iron ore operations

Company	Type of operation,	Mineral wastes		
mine/mill location*	geology and ore mineralogy	Item	Rock	Mill tailings
7. Iron Ore Company of Canada, Carol Division, Carol Lake, Lab.	Open pit mine - iron ore Mill Capacity - 142 000 t/d; crushing, grinding, wet concentration by spirals and cones, magnetic separation, pelletizing	Amount**	Large (10 x 10^6 t/a)	Large (13 x 10^6 t/a)
	Chemical and claustic sediments of Labrador Trough; rock types include iron formation, quartzite and shales; ore consists of hematite and goethite/limonite, with minor magnetite, quartz, kaolinite and iron silicates	Constituents***		P.C. - quartz M.C. - siderite, dolomite, ankerite
		Current or potential use	Rock dump disposal.	Tailings pond disposal; possible recovery of iron

* Locations shown in Fig. 1.

** Amount accumulated: large > 10 x 10^6 t
annual rate of accumulation shown in brackets

***P.C. - principal constituents, > 10%
M.C. - minor constituents, < 10%

Table 4 (cont'd)

8. Wabush Mines, Wabush, Lab.	Open pit - iron ore	Amount**	Large (3.5×10^6 t/a)	Large (10.7×10^6 t/a)
	Mill capacity - 17 000 t/d; crushing, grinding, sizing by spirals, magnetic separation, pelletizing, (mill at Wabush, pelletizing plant at Point Noire)	Size pH Relative density	Minus 1.5 m	40% minus 150 µm 6.8 3.2
	Ore and associated minerals include specular hematite, magnetite, quartz, pyrolucite	Constituents***	Quartzite, silicates, chlorites	P.C. - quartz and pyrite, (Si 63%, Fe 21.4%) M.C. - limonite, goethite, hematite, (Mg 1.8%)
		Current or potential use	Smaller sizes or quartzite waste rock are used on haulage roads, the remainder is sent to waste dump; potential use in dam and dike construction	Tailings pond disposal; recovery of fine iron from mill tailings is carried out using flotation, wet magnetic, and gravity methods of separation

Table 5 - Mineral wastes, industrial mineral operations

Company mine/mill location*	Type of operation, geology and ore mineralogy	Mineral wastes		
		Item	Rock	Mill tailings
9. Advocate Mines Limited, Baie Verte, Nfld.	Open pit mine - asbestos	Amount**	150 x 10^6 t (12 x 10^6 t/a)	30 x 10^6 t (2.2 x 10^6 t/a)
	Mill capacity - 6350 t/d; crushing, fiberizing, air separation	Size	Up to 1 m	90% minus 70 mm, 50% minus 40 mm
	Ore and associated minerals include chrysotile and serpentine	Constituents***	Serpentinized peridotite 60%, volcanics and meta volcanics 40%	P.C. - serpentinite (98.5%) M.C. - asbestos fibre (1.0%), magnetite
10. Aluminium Company of Canada Limited, Nfld. Fluorspar Works, St. Lawrence, Nfld.	Underground mine - fluorite	Amount**	None accumulated	
	Operations closed 1978	Size	Minus 40 mm, plus 3 mm	
	Ore and associated minerals include fluorite in granite	Constituents***	Granite, minor fluorite	
		Current or potential use	Used as backfill when mine was operating	
11. The Canadian Salt Company Limited, Pugwash, N.S.	Underground mine - salt	Amount**	Nil	Substantial (250 000 t/a)
	Mill capacity 500 t/d; crushing and screening	Size		Minus 30 mm
	Diaperic evaporite deposit contains salt intermixed with anhydrite and siltstone	Constituents***		Salt content is very high initially but decreases with subsequent leaching; anhydrite initially 5%, increases to 90% after several years of leaching
		Current or potential use		Land (swamp) fill at present; underground disposal being considered

* Locations shown in Fig. 1.

** Amount accumulated: substantial - 1 to 10 x 10^6 t
annual rate of accumulation shown in brackets

***P.C. - principal constituents, > 10%
M.C. - minor constituents, < 10%

Table 6 - Mineral wastes, coal operations

Company	Type of operation,	Mineral wastes	
mine/mill location*	geology and ore mineralogy	Rock	Mill tailings
Cape Breton Development Corporation, Sydney, N.S.			
Mines			
12. Lingan colliery, New Waterford, N.S.	Underground mine - coal; undersea, longwall, advancing; Pennsylvanian-Westphalian C and D, high volatile A and bituminous coal		
	Processing includes scalping of 250 mm, screening and crushing to 40 mm; crushed product sent to Victoria Junction and Sydney Mines plants for processing	Scalped rock, plus 250 mm, 35 000 t/a, consists principally of shale and sandstone with minor coal, sent to waste dump	
13. Prince colliery, Point Aconi, N.S.	Underground mine - coal; undersea, under development; Pennsylvanian-West-phalian C and D, high volatile A and bituminous coal		
	Processing consists of scalping at 200 mm; crushed product sent to Sydney Mines plant for processing	Scalped rock, plus 200 mm, 2500 t/y at present - will increase to 20 000 t/y when mine is fully developed; principally consists of shale, sent to waste dump	

* Locations shown in Fig. 1.

Company mine/mill location*	Type of operation, geology and ore mineralogy	Mineral wastes		
			Rock	Mill tailings
14. No. 26 colliery, Glace Bay, N.S.	Underground mine - coal; undersea, longwall advancing; Pennsylvanian-Westphalian C and D, high volatile A and bituminous coal Output crushed to 40 mm and sent to Victoria Junction plant for processing			
Coal preparation plants				
15. Victoria Junction, Sydney, N.S.	3×10^6 t/a	Amount**	700 000 t (250 000 t/a)	400 000 t (100 000 t/a)
	Mill capacity - 3×10^6 t/a; processing includes crushing, heavy media separation and flotation	Size	Minus 40 mm plus 0.5 mm	Minus 0.5 mm
		pH		7.3
		Relative density		2.0
		Constituents***	Shale, sandstone, pyrite	P.C. - shale, sandstone, coal (25%) M.C. - pyrite (5%)
		Current or potential use	Approximately 100 000 t of this material was sold to the Bahamas in 1979 for portland cement production; waste has been studied as source of alumina for aluminum metal manufacture and, at CANMET as raw material for lightweight aggregate for concrete (11)	Tailings pond disposal; of potential interest as a source of coal

** Amount accumulated: small < 1×10^6 t annual rate of accumulation shown in brackets

***P.C. - principal constituents, > 10% , M.C. - minor constituents, < 10%

Table 6 (cont'd)

16. Sydney Mines, Sydney Mines, N.S.		Amount	Substantial (100 000 t/a)	
	Mill capacity 200 t/h; processing includes washing and gravity separation by Baum jig	Size	Minus 250 mm	
		Constituents***	Shale, sandstone, coal (25%)	
		Current or potential use	Of interest as a potential source of coal	
17. River Hebert Coal Company Limited, River Hebert, N.S.	Underground mine - coal	Amount**	Small - dump measures 6 x 9 x 300 m	Nil
	Dry Screening	Current or potential use	Nil	
18. Thorburn Mining Limited, Stellarton, N.S.	Coal waste reclamation project	Amount**	445 000 t (118 000 t/a)	25 000 t (total)
	Mill capacity - 100 t/h; processing includes treatment by water cyclones and jigs	Size	Minus 150, plus 0.5 mm	Minus 5 mm
		pH		8.0
		Relative density		2.2
		Constituents***	Shale and sandstone	P.C. - combustible coal (50%), shale and sandstone (49%), mica, quartz, kaolinite M.C. - pyrite and chalcopyrite (1%)
		Current or potential use	Waste dump disposal (possible ski hill)	Waste dump disposal; potential source of additional coal

Table 6 (cont'd)

Company mine/mill location*	Type of operation, geology and ore mineralogy	Mineral wastes		
		Item	Rock	Mill tailings
19. N.B. Coal Limited, Minto, N.B.	Open pit mine - coal.	Amount**	1 300 t/a	Small
	Mill capacity 1 000 t/d.	Size	Minus 150 mm	Minus 40 mm
		pH		6.8
		Relative density		2.5
		Constituents***	Coal rock, slate, sulphur balls	P.C. - mud, rock, sulphur balls, quartz, pyrite M.C. - slate, mica
		Current or potential use	Waste dump disposal	Waste dump disposal

Data for Tables 3 to 6 were obtained from a variety of sources including mine and mill operators, laboratory studies of representative samples, a preliminary report "Mineral Wastes in the Atlantic Provinces" (5), "Operators Lists 1 and 4" (6,7), and from the technical press. Tables 7 and 8 were developed by CANMET staff using representative samples obtained from operating companies.

The 19 mining and milling operations studied are identified by corresponding numbers in Tables 2 to 8 and on the map, Fig. 1.

BASE METAL OPERATIONS

A variety of base metals, including antimony, copper, lead and zinc, are produced in the Atlantic Provinces along with co-product gold and silver. Production is largely from underground mines where waste rock production is minimal. Waste rock is used underground as backfill but may be brought to the surface as required for road and dike construction. Production of mill tailings, by contrast, is substantial and the bulk of this is sluiced to tailings disposal areas. Some tailings may contain significant quantities of recoverable minerals or metals. For example, there is current interest in the recovery of an estimated 500 000 t of barite from the copper-zinc-lead tailings at Buchans, Nfld. for use in oil-well drilling mud (8). Such recovery has been shown to be technically feasible (9). Dolomitic mill tailings from a zinc mining and milling operation at Daniel's Harbour, on the west coast of Newfoundland, have been used experimentally as a soil additive. Tailings from the operations of Brunswick Mining and Smelting Corporation Limited, near Bathurst, N.B., contain potentially recoverable iron, sulphur and silver, and possibly lead and

Table 7 - Mineralogy of mill tailings

Sample	Constituents		
No.	>20%	10 to 20%	<10%
Base metals			
1	barite	quartz	mica, pyrite
2	pyrite, quartz	---	plagioclase
3	dolomite	---	quartz
5	quartz	mica	kaolinite
6	pyrite	quartz	plagioclase, magnetite
Iron ore			
8	quartz, hematite	---	goethite
Industrial minerals			
9	serpentine	---	magnetite
Coal			
16	mica, quartz, kaolinite	---	pyrite, magnetite
18	mica, quartz, kaolinite	---	---
19	pyrite	quartz	mica

Table 8 - Chemical analyses of mill tailings

Sample No.	Compound %							
	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	Ba	S	LOI
Base metals								
1	47.24	3.76	10.07	2.07	1.67	20.0*	4.82	2.60
2	29.14	35.94*	8.35	4.08	2.02	--	25.79	17.21
3	2.02	0.24	2.10	26.68	21.28	--	0.09	45.11
4***	9.64	79.71**	1.13	1.68	0.83	--	38.90	2.60
5	74.70	4.12	11.96	1.26	1.03	--	1.17	3.60
6	11.58	60.13**	2.68	2.31	0.88	--	37.00	23.99
Iron ore								
8	52.62	32.60	4.19	0.46	0.23	--	0.02	2.00
Coal (dry basis)	H_2O	Ash	Volat. mat.	Fixed C	Cal per g	B.T.U. per lb	S	LOI
16	0.67	50.67	20.13	29.20	3836	6904	1.89	49.70
18	1.55	67.29	16.48	16.23	1945	3501	0.63	34.05
19	1.62	51.50	22.77	25.73	3166	5699	21.89	49.31
Coal (ash analysis)	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	K_2O	SO_3	P_2O_5
16	49.29	13.88	24.56	1.84	1.75	4.14	1.75	0.06
18	53.73	10.42	26.91	1.26	1.06	3.04	0.74	0.18
19	21.81	57.05	9.02	3.96	0.29	1.04	4.41	0.35

* Calculated

** Reported as Fe_2O_3, mostly present as pyrite/pyrrhotite

***From Mines Branch Report, IR 73-19, 1973

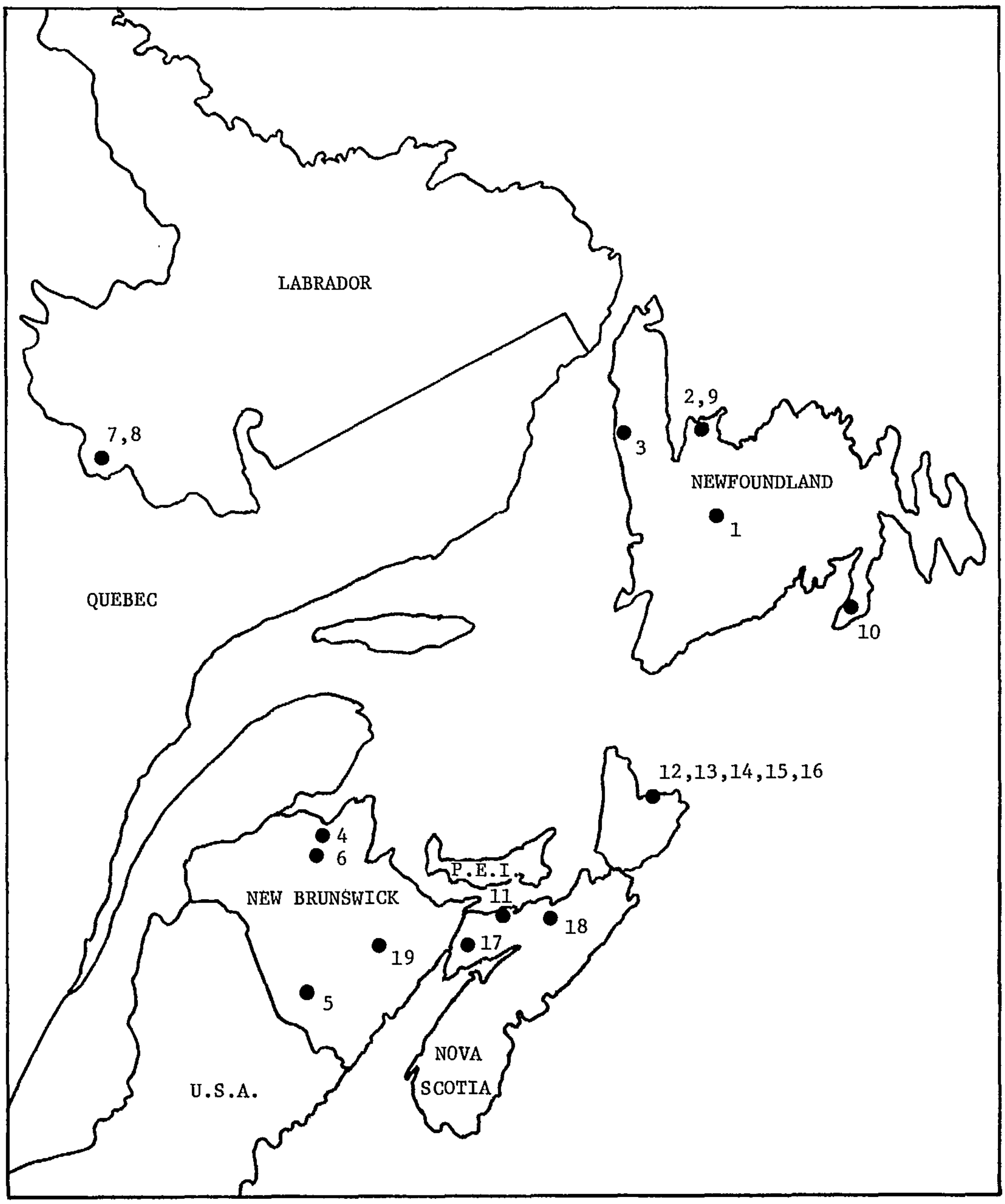

Fig. 1 - Mining/mineral processing operations listed in Table 2

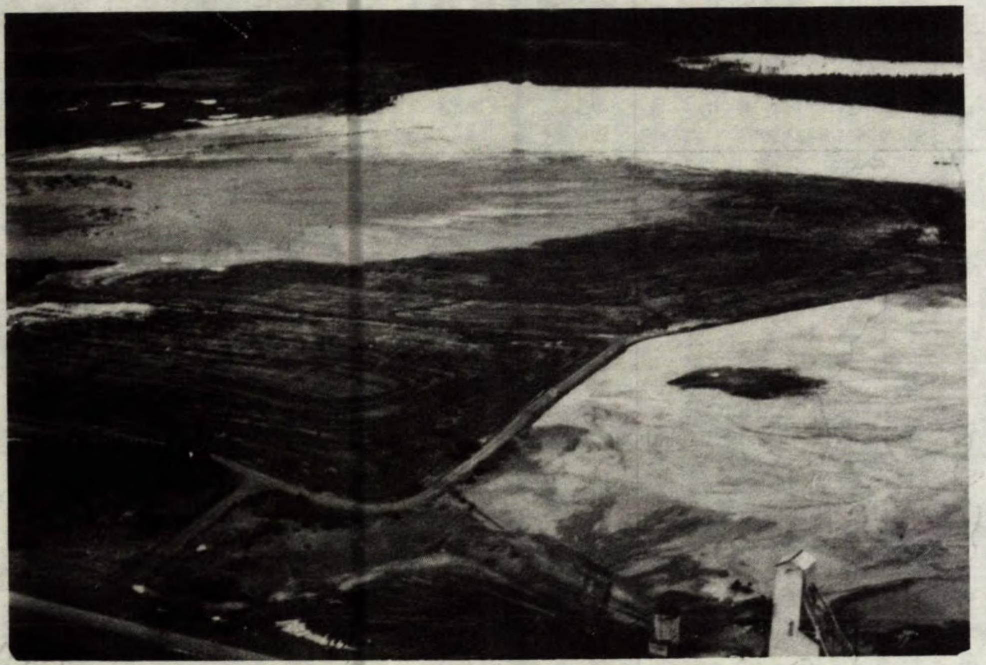

Fig. 2 - Mill tailigs at ASARCO Incorporated, Buchans, Nfld. (Photo courtesy ASARCO Incorporated)

zinc. Tailings from Heath Steele Mines Limited, near Newcastle, N.B., similarly contain significant quantities of potentially recoverable iron, sulphur and silver, and possibly lead, zinc and copper. Quartz tailings from the Lake George antimony mine of Consolidated Durham Mines and Resources Limited, near Prince William, N.B., have been used experimentally as foundry moulding sand and are of potential value for sandblasting brick and stone facings of buildings.

IRON ORE OPERATIONS

Iron ore production in the Atlantic Provinces is restricted to open pit mining operations at two locations in Labrador - Carol Lake and Wabush. Large quantities of waste rock are produced at each but, apart from limited use in road and dike construction, this rock is trucked to waste disposal areas. Mill tailings production is similarly large, with the bulk being piped to disposal areas. These tailings contain significant quantities of potentially recoverable iron. Studies have been made with the objective of recovering this, principally by gravity and froth flotation (10).

INDUSTRIAL MINERAL OPERATIONS

Industrial minerals produced in the Atlantic Provinces include asbestos, gypsum, pyrophyllite, salt, sand and gravel, dimension stone, crushed stone, and silica. Although some are mined underground most are produced from surface operations. The major output from the standpoint of quantity is gypsum, with all production being derived from open pit mines. Overburden, which consists chiefly of earth and boulder clay, is the principal waste from gypsum mines and has virtually no value. Sand and gravel, and dimension stone and crushed stone operations are fairly numerous and may produce limited quantities of waste or unwanted sizes. These wastes find use in road construction but such operations are not

Fig. 3 - Mill tailings at Advocate Mines Ltd., Baie Verte, Nfld. (Photo courtesy of Advocate Mines Ltd.)

covered in detail in this report.

Significant quantities of waste rock and mill tailings are produced at the asbestos mine of Advocate Mines Ltd., near Baie Verte, Nfld. The rock may be used in road construction but most is trucked to disposal dumps. Mill tailings are conveyed to dumps. They contain about 1% of potentially recoverable asbestos fibre that may be useful as a filler material in plastics and possibly in rubber. At Pugwash, N.S., the Canadian Salt Company Limited, uses a waste anhydrite-salt mixture from salt mining and processing operations to landfill swampy areas in the plant vicinity. The possibility of disposing of this material in underground workings is being studied.

COAL OPERATIONS

Production of coal in the Atlantic Provinces is confined to Nova Scotia, at underground mines in the northern half of the province, and to New Brunswick at an open pit mine in the Minto area.

Waste rock production is not large and is mostly sent to storage dumps. It consists essentially of shale and sandstone although some dumps contain up to 25% of potentially recoverable coal. An interesting use of waste from DEVCO's processing plant at Victoria Junction was the shipment in 1979 of 100 000 t to the Bahamas for use in portland cement manufacture. The coral limestone used there for cement manufacture is deficient in alumina, silica and iron, which are significant constituents in the coal wastes. Potential uses for waste rock from coal processing include the recovery of alumina (11), and as raw material for the production of light-weight concrete aggregate (12). A 1971 study by the Mines Branch, Ottawa, of the recovery of coal from a waste bank at Springhill, N.S., recommended that rejects from the process be evaluated as road building material (13). Although coal was never recovered, the burned material, "red dog", now is

Fig. 4 - Coal waste bank at Springhill, N.S. (Photo courtesy of T.E. Tibbetts, CANMET)

utilized for road building in the Springhill area.

Fine-sized coal wastes are produced at several locations. These consist chiefly of shale, sandstone, coal and pyrite. The coal is potentially recoverable and may vary from 25%, as at DEVCO's Victoria Junction plant, to a reported 50% at the coal recovery operation of Thorburn Mining Limited at Stellarton, N.S.

CONCLUSION

This report presents available data on the physical, chemical and mineralogical nature of mining wastes in the Atlantic Provinces. It shows that some wastes may be of interest for the recovery of contained metals and minerals and as raw material for various industrial uses. In some instances the physical nature of the material, e.g., particle size and size distribution, may have to be altered to meet requirements for a potential use; in others, chemical specifications of raw material for a particular use may be unnecessarily stringent. Thus the waste producer may be obliged to undertake further processing, or the consumer may have to lower specifications to permit use of a particular mineral waste. Cooperation at all stages is the key to wider utilization.

The identification and development of viable uses for mineral wastes constitute a complex problem. The successful application of mineral wastes to particular end uses cannot be accomplished without extensive laboratory research and process development. However, the quantity and variety of raw material and the diversity of possible end uses together present a challenge that should not go unheeded by industry and government, especially in view of developing shortages of energy and, in certain areas, of mineral raw materials. Answers will be difficult to find but the rewards may well be worth while.

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