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MINERAL WASTE RESOURCES OF CANADA REPORT NO. 2 - MINING WASTES IN QUEBEC

R.K. Collings

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MINERAL WASTE RESOURCES OF CANADA
REPORT NO. 2 - MINING WASTES IN QUEBEC*

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 wastes as possible supplemental sources of mineral raw material. Current annual production of such wastes by the mining industry of Canada is in the order of 350 million tons. Only a small quantity of this is used, however, because of such factors as remote location, low purity or lack of information on their nature and possible uses. Current applications include road construction and maintenance, railroad ballast, smelter flux, and mine backfill. Other uses being studied by researchers within and outside CANMET include the recovery of contained metal and minerals, the production of concrete and construction aggregate, the manufacture of bricks, blocks, and mineral wool insulation, and as a soil additive or neutralizer.

This report provides background information on waste rock and mill tailings in Quebec which annually produces about 140 million tons. Data on the occurrence, mineralogy, physical and chemical characteristics of wastes from thirty-three operating mines are provided in tabular form for the four principal types of mines - base metals, iron ore, precious metals, and industrial minerals. Potential uses for certain wastes are noted along with relevant research.

Several of the mining and mineral processing wastes of Quebec are of particular interest. Asbestos tailings from the Eastern Townships contain potentially recoverable short fibre, magnesium, iron, nickel and chromium, and may also be useful for producing mineral wool. Waste rock and mill tailings from the recently defunct Hilton Mines Limited at Shawville hold promise - the

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* Project MRP 3.3.5.1.01 - Identification and Characterization of Mineral Wastes.

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former as construction aggregate, the latter for making dry-pressed building brick. Calcite tailings from the columbium oxide mine formerly operated at Oka by St. Lawrence Columbium and Metals Corporation Limited can serve as a neutralizer for acid soils and plant effluents. Tailings from Canadian Refractories Limited at Kilmar are of potential value as a source of refractory-grade magnesia.

Future development of viable uses for mineral waste is a complex problem that will require the full co-operation of producers and potential consumers at all stages. Solutions, although difficult to find, will aid conservation of Canada's native, non-renewal mineral resources and help to reduce pollution.

RESSOURCES CANADIENNES EN REBUTS MINERAUX
RAPPORT N^{O} 2 - LES REBUTS MINERAUX AU QUEBEC*

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 350 millions de tonnes. 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 couramment pour la construction et l'entretien des routes ou comme ballast, comme fondant dans les fonderies et 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, 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'établissements de broyage du Québec dont la production annuelle s'élève à environ 140 millions de tonnes. Les données concernant l'abondance, la minérologie et les propriétés physiques et chimiques des déchets des trente-trois mines en exploitation sont disposées en tableaux pour les quatre principaux types de mine: métaux communs, minerai de fer, méteux nobles et minéraux industriels. Les usages possibles de certains déchets et la recherche pertinente sont mentionnés.

Plusieurs des déchets d'établissements d'extraction et de traitement des minéraux du Québec présentent un intérêt particulier. Dans les cantons de l'Est, les déchets d'amiante

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* Projet MRP 3.3.5.1.01 - Identification et caractérisation des minéraux résiduels.

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contiennent des fibres courtes, du magnésium, du fer, du nickel et du chrome qui pourraient être récupérés et qui peuvent aussi servir à la production de laine minérale. Les roches résiduelles et les déchets de broyage de la Société Hilton Mines Limited (Shawville), qui a été récemment dissoute, ont un potentiel certain: les roches résiduelles pourraient servir d'agrégats dans le secteur de la construction et les déchets de broyage pourraient être utilisés pour la fabrication, par pressage à sec, de briques de construction. Les déchets de carbonate de calcium naturel de la mine d'oxyde de niobium qui était autrefois exploitée à Oka par la St. Lawrence Columbium and Metals Corporation Limited peuvent servir de neutralisants dans les sols acides et dans les effluents d'usines. Les déchets de la Canadian Refractories Limited, de Kilmar, pourraient éventuellement servir de source de magnésie de qualité réfractaire.

Le développement futur d'usages rentables des minéraux résiduels soulève un problème complexe qui nécessitera l'entière collaboration de tous les producteurs et consommateurs éventuels. Même si elles sont difficiles à trouver, les solutions nous aideront à économiser les ressources minérales non renouvelables du Canada et à réduire la pollution.

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INTRODUCTION

Canada has large resources of most metallic and non-metallic minerals, however, these resources are non-renewable and many higher-grade deposits are steadily being depleted as the mining industry strives to satisfy the ever increasing demand for minerals and metals. To meet current and projected requirements for metals, mining companies are finding that they must search farther afield, often in remote areas of Canada, for new ore bodies. Similarly, exhaustion of reserves of industrial minerals in favourably located deposits, and legislation restricting mining near urban centres, are forcing operators to look for and 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 concentrate to markets. These factors have stimulated research into the technical and economic feasibility of recovering mineral and metal values from lower-grade but often more accessible mineral deposits, including mining wastes. This report is concerned with mining wastes in the province of Quebec.

Mining wastes are being generated and accumulated at a rate in excess of 350 million tons per year in Canada. Of this, Quebec accounts for approximately 140 million tons. Such wastes normally have been of little interest and, in fact, have represented additional expense in that they are costly to treat and to maintain in dumps and tailing ponds. Today, however, they are being examined more closely. Environmentalists, on the one hand, are concerned with the 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., magnesium, iron and nickel from asbestos tailings, and of using mining wastes as raw material for manufacturing various products, e.g., bricks and blocks, and in various applications such as soil additives, e.g., the use of high-carbonate tailings to neutralize acid soils.

This current interest in mineral wastes has resulted in an increased need for more information on their physical and chemical nature. The Mines Branch (now CANMET, the Canada Centre for Mineral and Energy Technology) initiated a long-term study of domestic mineral wastes in 1970-71 to determine the magnitude and nature of mineral waste resources; to investigate the technical feasibility of using these wastes for certain products and of recovering contained mineral values; and to encourage further research by industry. As part of the study, five preliminary reports of sources of mineral wastes in Canada were prepared in 1972[1 to 5]. These internal, unpublished reports were used as a basis for research in the field of mineral waste utilization by a small group of CANMET scientists. Although their distribution was limited, interest in these reports has been keen. A decision was made to update and publish them to ensure that the information would be available to all interested groups. The present report, Mining Wastes in Quebec, is the second of a series. The first, Mineral Waste Resources of Canada, Report No. 1 - Mining Wastes in Ontario, CANMET Report 76-2, was published early in 1976. Forthcoming reports over the next several years will be devoted to British Columbia, the Prairie Provinces, and the Atlantic Provinces. These will deal with waste from operating mines only; wastes from certain abandoned mines and from the metallurgical and chemical industries are also of interest and will be documented later.

MINERAL WASTES

The preliminary reports[1 to 5] contained a tabulation on mineral wastes by types. This is reproduced in modified form in Table 1 as an aid to classifying and understanding the nature of mineral wastes. Wastes are divided into four general categories. Those in the first two are large-volume, low-grade mixtures of minerals and, as such, are usually unattractive for further economic exploitation although overburden material can be used locally for roads or as land-fill, and waste rock may be useful as railroad ballast and as general construction and concrete aggregate. However, in most instances, the problem of storage of such wastes is best solved by long-term, planned stabilization or landscaping. This provides areas that may have greatly increased value as building sites or for recreational use. The last two groups include wastes which have been partially processed and are often uniform in character and grain size. They may, on the one hand, contain significant metal and mineral values or, on the other, they could represent potential sources of raw materials for use as construction materials, in ceramic products, and in various miscellaneous applications. The mining

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 mines, 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, 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 additional metal and mineral values, and raw material for the manufacture of bricks and blocks, soil fertilizers and additives, mineral fillers, chemicals, etc.	

wastes considered in this report, i.e., waste rock and mill tailings, belong to Groups 2 and 3 respectively.

MINING WASTES IN QUEBEC

For ease of reference, information on mining wastes in Quebec is presented in tabular form in Tables 3 to 9, pages 20 to 43. These tables list the main operating mines, provide brief descriptions of the type of operation, geology and ore mineralogy, and describe the types of mineral wastes produced. Tonnage estimates and current and potential uses are noted. In addition, chemical, spectrochemical, and mineralogical data are given for about twenty-five select samples of mill tailings. The many sand and gravel pits and stone and crushed stone quarries have not been included although waste fines and coarse material may occasionally be available at such operations. As an aid to the reader, wastes are separated into four general categories based on origin as follows:

1. Base Metals (Table 3)
2. Iron Ore (Table 4)
3. Precious Metals (Table 5)
4. Industrial Minerals (Table 6)

Data for Tables 3 to 6 were obtained from a variety of sources including mine and mill operators, laboratory studies of representative waste rock and mill tailing samples, the preliminary Source Report of Mineral Wastes in Quebec[3], returns from a questionnaire to the mining industry by Environment Canada, and from the technical press. Data from these tabulations should be studied and evaluated with that from Table 7, Mineralogy - Mill Tailing Samples, Table 8, Semi-Quantitative Spectrochemical Analyses - Mill Tailing Samples, and Table 9, Chemical Analyses - Mill Tailing Samples, to arrive at a fuller appreciation of the nature and potential usefulness of these wastes. Data in these last three tables (7 to 9) were developed by CANMET staff and are based on representative samples of mill tailings obtained from operating companies.

The thirty-three mining operations considered in this report are identified by numbers 1 to 33 in Tables 2 to 9 on pages 17 to 43. They are similarly identified by corresponding numbers on the Quebec map in Figure 5 on page 19.

Base Metal Mines

With the exception of two mines in the Gaspé Peninsula and two or three in the upper St. Lawrence River area, base metal mining operations - copper, lead, zinc, nickel - are concentrated in northwestern Quebec. Most are underground, the chief exception being the open pit of Gaspé Copper Mines Ltd. at Murdochville, shown in Figure 1, page 7.

Waste rock from underground base metal mines does not normally represent a large quantity, except during the development stage. This rock is usually left underground as backfill but it may be brought to the surface and used for road construction and maintenance. Waste rock from open pit mines, by contrast, may equal or exceed the tonnage of ore mined. This rock is usually

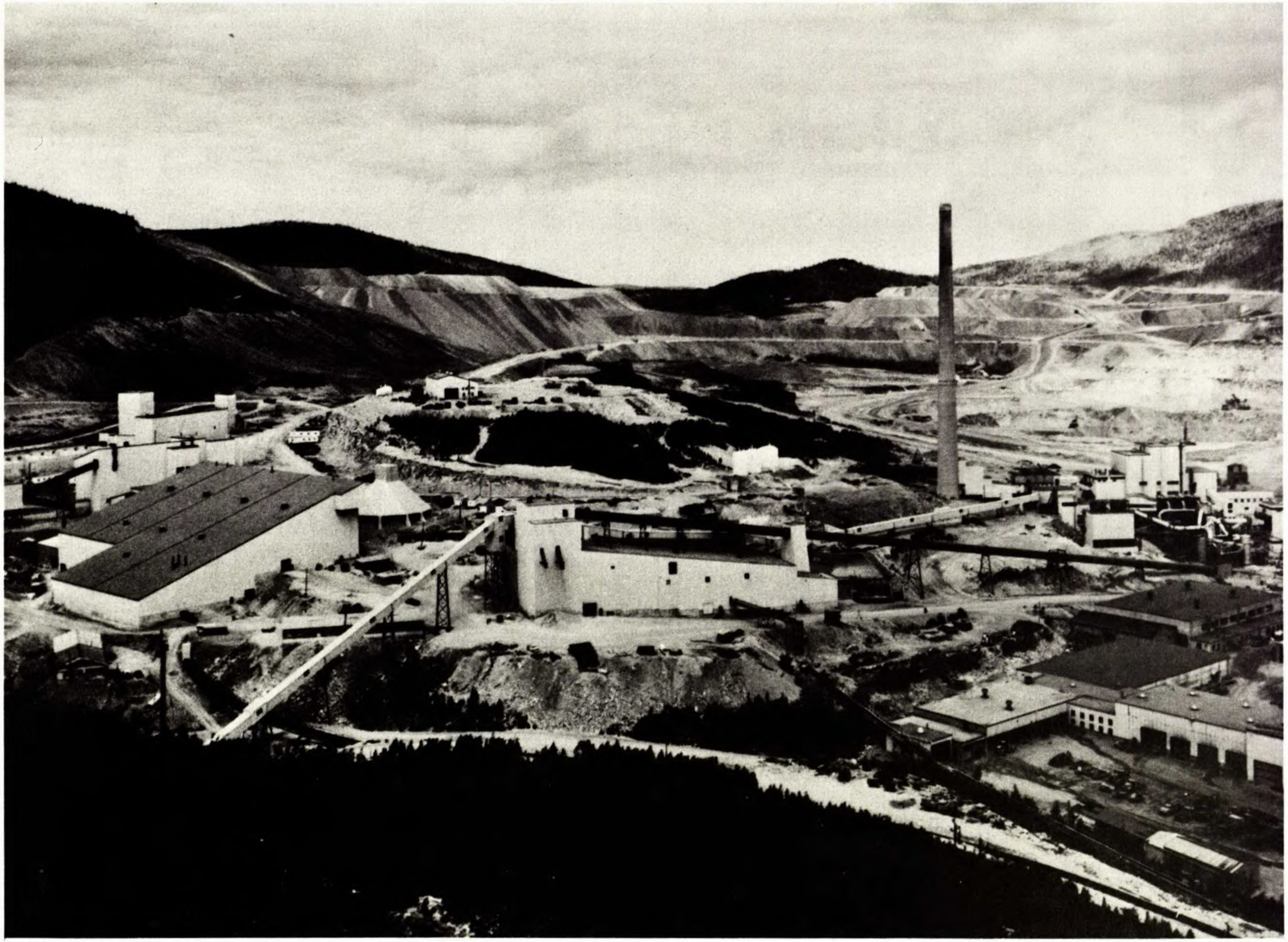

Figure 1. Open pit of Gaspé Copper Mines Ltd. at Murdochville, showing waste rock dumps in background (photo by George Hunter).

stockpiled but may find limited local use in road construction and as construction aggregate. Large-tonnage uses are few because of the remote locations of many of the mine sites, e.g., Murdochville in the Gaspé Peninsula.

Mill tailings from base metal mining operations represent millions of tons per year. They are finely ground and may contain large amounts of metallic sulphides, chiefly pyrite and pyrrhotite which could be recoverable for conversion to sulphuric acid if sulphur supplies become critical. The impure nature and remote location of these tailings limit their use to local, low-grade applications, e.g., as mine backfill, in road maintenance and, on occasion, as smelter flux. Mill tailings may also contain small but significant amounts of metals that could perhaps be recovered in the future should metal prices increase sufficiently. In the meantime, some base metal tailing piles are being revegetated and used as public parks or as wildlife areas.

Current base metal mining operations in Quebec with available data on waste rock and mill tailings are noted in Table 3, page 20.

Iron Mines

Iron ore mining operations, with the exception of the Hilton mine at Shawville, are all in northeastern Quebec and all are open pits.

These mines produce large quantities of waste rock and whereas the bulk is sent to rock dumps, minor amounts are used locally in road construction, as crushed stone and construction aggregate, and, on occasion, as railroad ballast. Granitic waste rock from Shawville, for example, has been used as aggregate and also as railroad ballast. This rock is currently being studied by CANMET investigators for suitability as aggregate in concrete.

Iron ore milling and processing operations produce large amounts of mill tailings, most of which is sent to disposal areas. Minor but significant quantities are used as fine aggregate in concrete and in road construction and maintenance. Interest has been expressed in the possibility of producing building brick from certain of these tailings. CANMET researchers have demonstrated the technical feasibility of producing a dry-pressed, facing brick with tailings from the Hilton mine at Shawville(6).

The open pit of Hilton Mine Limited is shown in Figure 2, page 10. This operation was closed early in 1977. Iron ore mining operations in Quebec, with available data on waste rock and mill tailings, are listed in Table 4, page 27.

Precious Metal Mines

Gold and silver mining operations are largely concentrated in northwestern Quebec. Mining is by underground methods and waste rock production is usually not significant. Waste rock is usually left underground where it is used as backfill although it may be brought to the surface for use in mine road construction.

Mill tailings, by contrast, are produced in large quantities. They may, on occasion, be used as mine backfill but are usually sluiced to disposal areas where they may be vegetated as shown in Figure 3, page 11, to reduce dusting, erosion, and pos-

Figure 2. Open pit iron mine of Hilton Mines Ltd. near Shawville, showing waste rock dumps, upper left, and tailings pond, upper right (photo by Lister, M.&T.S., Ottawa, 1966).

Figure 3. Revegetation of gold mill tailings at East Malartic Mines Ltd., Malartic (photo courtesy East Malartic Mines Limited).

sible surface or ground water contamination from runoff and seepage. Some tailings may contain traces of gold and silver which could become attractive with future price increases. These wastes are finely ground and usually contain relatively large percentages of quartz and feldspar with only minor amounts of metallic sulphides, e.g., pyrite and pyrrhotite. Such tailings could be of interest for building products manufacture, e.g., sand-lime brick and concrete block, if research indicates technical feasibility and if markets are large enough to justify the establishment of manufacturing facilities. Current requirements of brick for northwestern Quebec are brought in from distant centres such as Toronto, Ottawa, and Montreal. Research by CANMET investigators into the feasibility of using tailings from gold and silver mines for sand-lime and dry-pressed brick manufacture to date has produced inconclusive results[7]; however, further studies are planned.

Current precious metal mining operations in Quebec with available data on waste rock and mill tailings are listed in Table 5, page 30.

Industrial Mineral Mines

Asbestos is the chief industrial mineral produced in Quebec, the bulk of production being derived from open pit mines in the Eastern Townships. Other industrial minerals produced include silica, magnesitic dolomite, and talc. These latter operations are in southern Quebec within a 150-mile radius of Montreal.

Large quantities of waste rock are produced by open pit asbestos operations. The bulk of this waste is stockpiled in large dumps although minor amounts are used locally as roadfill or as mine backfill. Figure 4, page 13, shows waste rock dumps and mill tailings ponds at several asbestos operations in the

Figure 4. Open pit and mill of Lake Asbestos of Quebec Ltd. at Black Lake, showing waste rock dump and mill tailings (photo by George Hunter).

vicinity of Black Lake. Production of waste rock at most of the other operating industrial mineral mines is relatively small. Production of mill tailings, again with the exception of asbestos operations, is also relatively small; however, certain of these tailings are of interest, e.g., tailings from the columbium oxide plant at Oka are principally calcite and are of interest as a soil additive or acid neutralizer, and tailings from the magnesite-dolomite operation at Kilmar are of potential interest as a source of refractory-grade magnesia. Asbestos tailings are of particular interest from the standpoint of recovering additional mineral materials and have been studied fairly extensively in this regard. These tailings contain 5 to 10 per cent of short asbestos fibre along with significant amounts of magnesium, nickel, chromium, and iron. Studies have been made on the recovery of the short fibre by wet processing methods for use as reinforcing or filler material in concrete and plastics, and some work has been done on the recovery of magnesium, nickel, iron, and chromium[8,9]. Work undertaken at CANMET laboratories demonstrated the technical feasibility of producing mineral wool as well as an interesting nickel-iron co-product from these tailings[10].

Current industrial mineral operations in Quebec with available data on waste rock and mill tailings are listed in Table 6, page 33.

Additional Data

Additional data on the nature and composition of Quebec's mining wastes were obtained by submitting samples to CANMET laboratories for mineralogical, semi-quantitative spectrochemical, and chemical analyses. The results are given in Tables 7, page 40; 8, page 42; and 9, page 43.

CONCLUSION

This report presents available data on the physical, chemical, and mineralogical nature of mining wastes in Quebec and shows wherein some of these wastes may be of interest as source material for various applications or for use in the manufacture of a number of mineral-based products. It is hoped that the information contained herein will stimulate interest in mining wastes in that province and encourage both producer and potential consumer to work together toward the goal of optimum utilization of these materials. In some instances the physical nature, e.g., particle size and size distribution of the material may have to be altered to meet a potential use requirement; in others, chemical specifications for raw material for a particular use may be unnecessarily stringent. Thus the producer, on the one hand, may be obliged to undertake further processing of mineral waste, whereas the consumer may have to lower specifications to permit use of a particular waste. Cooperation is the key, for without it the ultimate potential of many mineral wastes will never be realized.

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

The author would be pleased to receive additional information, comments, and suggestions, particularly with regard to unique opportunities for increased utilization of specific mineral wastes.

TABLE 2

Company Name and Identification Number

Company Name, Mine/Mill Location	Identification Number
Base Metal Operations	
Campbell Chibougamau Mines Ltd., Chibougamau	1
Falconbridge Copper Ltd., Opemiska Div., Chapais	2
Gaspé Copper Mines Ltd., Murdochville	3
Louvem Mining Co. Inc., Val d'Or	4
Madeleine Mines Ltd., Boisbuisson Twp	5
Manitou-Barvue Mines Ltd., Val d'Or	6
Mattagami Lake Mines Ltd., Matagami	7
Normetal Mines Ltd., Normetal	8
Noranda Mines Ltd., Noranda	9
Orchan Mines Ltd., Matagami	10
Patino Mines Ltd., Chibougamau	11
Rio Algom Mines Ltd., Joutel	12
Sullivan Mining Group Ltd., Stratford Centre	13
Iron Ore Operations	
Hilton Mines Ltd., Shawville	14
Iron Ore Company of Canada, Shefferville (mine)	15a
Iron Ore Company of Canada, Sept-Iles (mill)	15b
Quebec Cartier Mining Company, Gagnon and Lac Jeannine	16a
Quebec Cartier Mining Company, Mount Wright	16b
Quebec Cartier Mining Company, Fire Lake	16c
Quebec Iron and Titanium Corporation, Lac Tio (mine)	17a
Quebec Iron and Titanium Corporation, Tracy (mill)	17b
Precious Metal Operations	
Agnico-Eagle Mines Ltd., Joutel Twp	18
Camflo Mines Ltd., Malartic	19
East Malartic Mines Ltd., Malartic	20
Lamaque Mining Company Ltd., Val d'Or	21
Sigma Mines (Quebec) Ltd., Val d'Or	22
Industrial Mineral Operations	
Asbestos	
Asbestos Corporation Ltd., Black Lake	23a
Asbestos Corporation Ltd., Thetford Mines	23b
Bell Asbestos Mines Ltd., Thetford Mines	24
Canadian Johns-Manville Co. Ltd., Asbestos	25
Carey-Canadian Mines Ltd., East Broughton	26
Lake Asbestos of Quebec Ltd., Black Lake	27

.....Table cont'd

TABLE 2 (cont'd)

Company Name and Identification Number

Company Name, Mine/Mill Location	Identification Number
Industrial Mineral Operations (cont'd)	
Other	
Baker Talc Ltd., South Bolton	28
Baskatong Quartz Products Ltd., Grand Remous	29
Broughton Soapstone & Quarry Ltd., St. Pierre de Broughton	30
Dresser Industries Canada Ltd., Kilmar	31
St. Lawrence Columbium & Metals Corporation, Oka	32
Union Carbide Canada Ltd., Melocheville	33

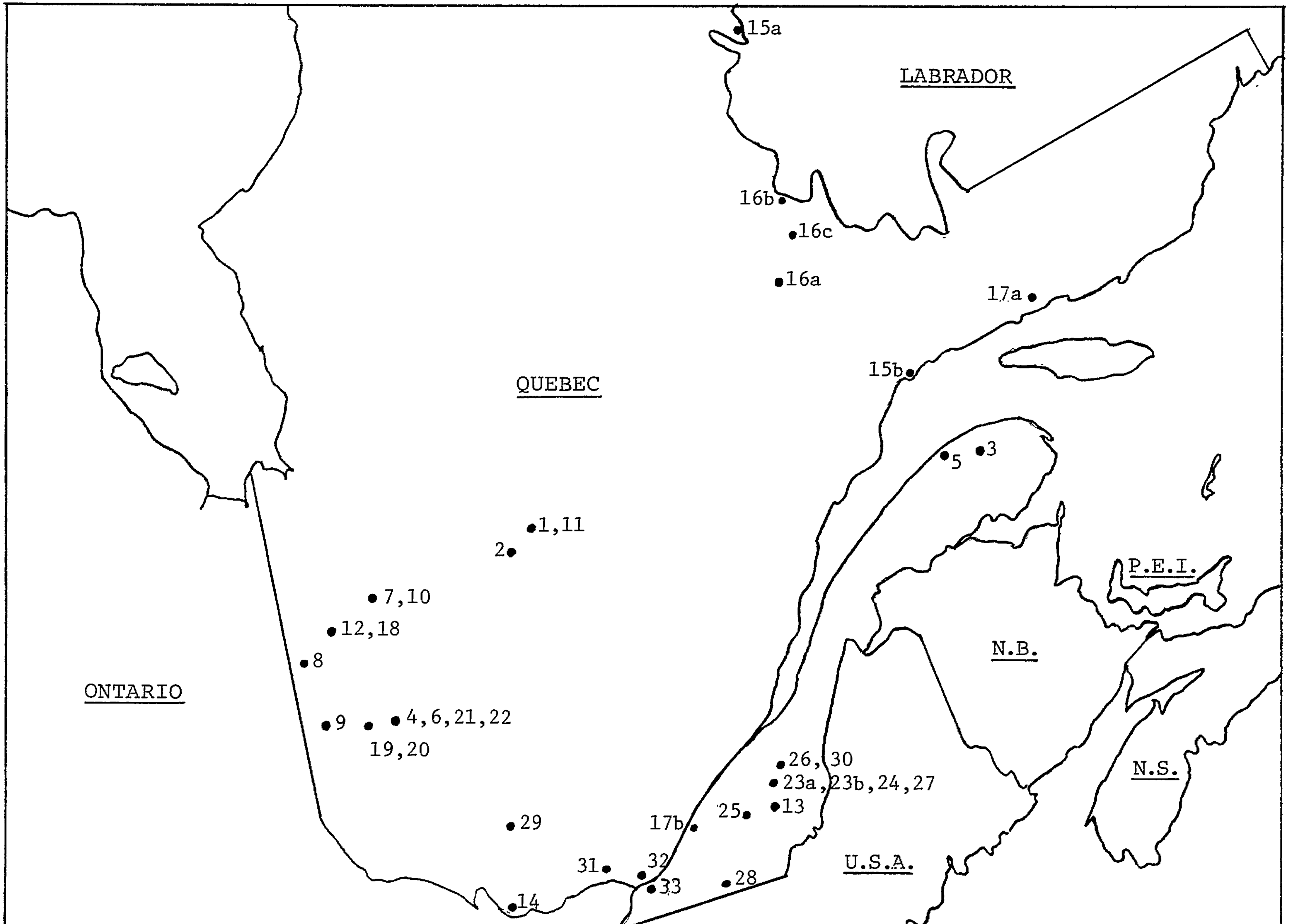

Figure 5. Location of mining/milling operations listed in Table 2.

TABLE 3

Mineral Wastes - Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
1. Campbell Chibougamau Mines Ltd., Chibougamau.	Underground mine - copper. Mill capacity - 4,000 tpd; crushing, grinding, sizing, flotation. Copper occurs in differentiated sill of diorite and anorthosite with chlorite, siderite, and sulphides.	Tonnage**	Small (800,000 tpy).	Small (600,000 tpy).
		Size, pH, Sp Gr	½ in. to 3 ft.	20% minus 100 mesh, 7.6, 3.05.
		Type or Constituents***	Principally anorthosite.	P.C. quartz 60%, other silicates 30%. M.C. quartz, calcite, other carbonates.
		Current or Potential Use	Landfill - could be of future interest as source of alumina although tonnage is limited.	Mine backfill (50%) and tailings pond disposal. Some research has been carried out relative to recovery of precious metals but recovery proved to be too costly.
2. Falconbridge Copper Ltd., Opemiska Division, Springer, Perry, and Cooke mines, Levy County, Chapais.	Underground mines - copper. Mill capacity - 3,000 tpd; crushing, grinding, sizing, flotation. Copper concentrate, containing gold and silver, is shipped to Noranda Mines at Noranda.	Tonnage**	Small (100,000 tpy).	Large, 335 acres (900,000 tpy).
		Size, pH, Sp Gr		85% minus 100 mesh, 8.9, 2.94.
		Type or Constituents***		P.C. feldspar, amphibole, chlorite, quartz, calcite. M.C. epidote, sulphide, gold, silver.
		Current or Potential Use	Waste rock dump.	Tailings pond disposal.

.....Table cont'd
Footnotes on p 26

TABLE 3 (cont'd)

Mineral Wastes - Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
3. Gaspé Copper Mines Ltd., Holland Twp., Murdochville.	Open pit and underground mine - copper and molybdenum. Mill capacity - 11,000 tpd (oxide plant), 22,000 tpd (sulphide plant). Leaching capacity - 5,000 tpd; crushing, grinding, sizing, flotation, leaching and precipitation.	Tonnage**	Large (7 million tpy).	88 million tons - (sulphide plant - 12 million tpy; oxide plant - 1.8 million tpy).
		Size, pH, Sp Gr		90% minus 100 mesh (sulphides), $\frac{5}{8}$ in. (oxides), 8.9, 2.96.
		Type or Constituents***	Quartzite, marble.	P.C. quartz, diopside, garnet. M.C. copper, molybdenum, feldspar.
	Chalcopyrite and other ore minerals are associated with altered porphyries, feldspar, quartz, shale, siltstone and limestone.	Current or Potential Use	Waste rock dump.	Tailings pond disposal.
4. Louvem Mining Co. Inc., Louvem Twp., Val d'Or.	Underground mine - zinc. Ore treated at Manitou-Barvue mill, Val d'Or; crushing, grinding, sizing, flotation.	Tonnage**	Small (35,000 tpy).	250 acres (127,000 tpy).
		Size, pH, Sp Gr	Variable, 2 ft and smaller.	65% minus 200 mesh, 5.2, 3.20.
		Type or Constituents***	Quartz-mica shist, finely disseminated pyrite; subordinate massive metavolcanic rocks.	P.C. quartz, mica, pyrite. M.C. zinc, copper, lead.
		Current or Potential Use	Road building at mine site and as backfill material.	Tailings pond disposal.

.....Table cont'd
Footnotes on p 26

TABLE 3 (cont'd)

Mineral Wastes - Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
5. Madeleine Mines Ltd., Boisbuisson and Lapotardiere Twps., Ste. Anne des Monts.	Underground mine - copper. Mill capacity - 2,500 tpd; crushing, grinding, flotation. Associated minerals and rocks include chalcopyrite, bornite, chalcocite, malachite, azurite, quartz-biotite hornfels, schist, skarn, graywacke, quartzite.	Tonnage**	30,000 tpy.	60 acres (860,000 tpy).
		Size, pH, Sp Gr	Minus 6 in., plus 1/4 in.	85 to 95% minus 200 mesh, 8.8, 2.83.
		Type or Constituents***	Quartz-biotite hornfels.	P.C. quartz, biotite, cordierite. M.C. diopside, garnet, calcite.
		Current or Potential Use	Tailings dam construction.	Tailings pond disposal; tailings too fine for backfill purposes.
6. Manitou-Barvue Mines Ltd., Bourlamaque Twp., Val d'Or	Underground mine - copper, lead, zinc, gold, silver. Mill capacity - 1,600 tpd; crushing, grinding, flotation. Ore minerals occur in tuff and agglomerate.	Tonnage**	Nil (10,000 tpy).	75 million (275 acres).
		Size, pH, Sp Gr	Variable, 2 ft. down.	80% minus 200 mesh, 6.5, 3.56.
		Type or Constituents***		P.C. quartz, carbonate, chlorite, sericite. M.C. metallics.
		Current or Potential Use	Tailings pond disposal, retainer wall construction and mine backfill.	Tailings pond disposal.

.....Table cont'd
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TABLE 3 (cont'd)

Mineral Wastes - Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
7. Mattagami Lake Mines Ltd., Galinee Twp., Matagami.	Underground mine - copper, zinc. Mill capacity - 3,850 tpd; crushing, grinding, flotation. Copper-zinc in acid and intermediate volcanics near anorthosite-gabbro complex.	Tonnage**	Minor (40,000 tpy).	Large (1.2 million tpy).
		Size, pH, Sp Gr		75% minus 200 mesh, 7.3, 3.50.
		Type or Constituents***	Metavolcanics: fine-grained, homogeneous, dense, green rock; rare grains of sulphides, white veinlets of calcite.	P.C. pyrite, pyrrhotite, magnetite, talc, quartz. M.C. chlorite, sphalerite, chalcopyrite, mica.
		Current or Potential Use	Used in tailings dam construction and in township work.	Approximately 50% of tailings used as mine backfill, remainder to tailings pond. Pyrite concentrate may be produced as required. Recovery of magnetite is being investigated.
8. Normetal Mines Ltd., Desmeloizes Twp., Normetal.	Underground mine - copper-zinc. Mill capacity - 1,000 tpd; crushing, grinding, sizing, flotation. Ore minerals occur in volcanic fragmental rocks with pyrite and pyrrhotite. Mine closed in 1975 because of exhaustion of ore.	Tonnage**	Minor.	175 acres (135,000 tpy).
		Size, pH, Sp Gr		85% minus 100 mesh.
		Type or Constituents***	Volcanic fragmental rocks.	P.C. pyrite, pyrrhotite. M.C. chlorite, quartz, calcite, biotite, plagioclase, sericite.
		Current or Potential Use		Future recovery of pyrite.

.....Table cont'd
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TABLE 3 (cont'd)

Mineral Wastes - Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
9. Noranda Mines Ltd., Horne Mine, Rouyn Twp., Noranda.	Underground mine - copper, gold. Mill capacity - 2,000 tpd; crushing, grinding, sizing, flotation, cyanidation. Massive sulphide bodies in rhyolite, tuff, and agglomerate. Mine expected to close in 1976.	Tonnage**	Minor (3,770 tpy).	220,000 tpy - sulphide tailings 350,000 tpy - slag.
		Size, pH, Sp Gr		Sulphide - 70% minus 200 mesh, 4.5, 3.07. Slag - 80% minus 325 mesh.
		Type or Constituents***		P.C. pyrrhotite, pyrite, silicates, silica (sulphide), magnetite (slag). M.C. copper, calcite, lead (sulphide), metallic copper (slag).
		Current or Potential Use	Waste rock is normally crushed and used for general construction and road maintenance.	
10. Orchan Mines Ltd., Galinee and Isle-Dieu Twps., Matagami.	Underground mine - zinc, copper. Mill capacity - 1,900 tpd; crushing, grinding, sizing, flotation. Massive to disseminated sulphides in rhyolitic rocks.	Tonnage**	50,000 (125,000 tpy).	11 acres (350,000 tpy).
		Size, pH, Sp Gr	Minus 12 in.	88% minus 200 mesh, 6.5, 3.56.
		Type or Constituents***	Rhyolite, gabbro, silicates.	P.C. pyrite, pyrrhotite, silicates. M.C. lead, zinc, copper.
		Current or Potential Use	Used as base for road and yard maintenance.	Mine backfill (40%). Remainder (fines) to disposal pond.

.....Table cont'd
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TABLE 3 (con

Mineral Wastes - Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
11. Patino Mines Ltd., Copper Rand Mine, Copper Cliff Mine, Bouzan Joint Venture, Chibougamau.	Underground mines - copper. Mill capacity - 2,850 tpd; crushing, grinding, sizing, flotation. Ore minerals occur in meta-anorthosite.	Tonnage**	50,000 tpy.	330 acres (800,000 tpy).
		Size, pH, Sp Gr		Minus 200 mesh.
		Type or Constituents***		P.C. pyrite, siderite, quartz, chlorite. M.C. sericite, pyrrhotite, magnetite.
		Current or Potential Use	Used in road maintenance and construction.	Tailings pond disposal.
12. Rio Algom Mines Ltd., Poirier Twp., Joutel.	Underground mine - copper-zinc. Mill capacity - 2,500 tpd; crushing, grinding, magnetic separation, flotation. Ore and associated minerals, pyrrhotite, sphalerite, chalcopyrite, pyrite, occur in rhyolite, talc, chlorite schist. Mine ceased production in 1975.	Tonnage**	70,000 tpy.	800,000 tpy.
		Size, pH, Sp Gr		90% minus 100 mesh, 75% minus 200 mesh.
		Type or Constituents***	Rhyolite, talc, chlorite.	P.C. pyrite, chlorite schist. M.C. sphalerite, chalcopyrite, talc, pyrrhotite.
		Current or Potential Use		

.....Table cont'd
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TABLE 3 (cont'd)

Mineral Wastes - Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
13. Sullivan Mining Group Ltd., Cupra Mine, d'Estrie Mine, Stratford Twp., Stratford Centre.	Underground mines - copper, lead, zinc. Mill capacity - 1,500 tpd; crushing, grinding, sizing, flotation. Ore from d'Estrie mine processed in Cupra mill. Ore minerals, chalcopyrite, sphalerite, galena, silver and gold, occur in sericite and chlorite schists.	Tonnage**	Minor.	Substantial (200 acres, 175,000 tpy).
		Size, pH, Sp Gr		90% minus 200 mesh, 5.2, 3.19.
		Type or Constituents***		P.C. pyrite, quartz, chlorite. M.C. sericite, gold, silver, copper, lead.
		Current or Potential Use		

* Locations noted in Figure 1.

** Tonnage accumulated:
- large - greater than 10 million.
- substantial - 1 to 10 million.
- small - less than 1 million.
- minor - less than 100,000.

*** P.C. - principal constituents, 10% or greater.
M.C. - minor constituents, less than 10%.

Note 1. Where determined, the pH of mill tailings is shown by a two digit number, and Sp Gr by a three digit number, following size designation in column 5 - Mill Tailings.

Note 2. Where information is not reported, some indication of the composition and nature of waste rock and/or mill tailings may be obtained by referring to column 2 - Type of Operation, Geology and Ore Mineralogy.

TABLE 4

Mineral Wastes - Iron Ore Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
14. Hilton Mines Limited, Shawville.	Open pit - iron. Mill capacity - 7,000 tpd; crushing, sizing, magnetic separation, pelletizing.	Tonnage**	19 million (1.4 million tpy).	18 million (1.1 million tpy).
		Size, pH, Sp Gr	Various sizes up to 18 in. or more.	35% minus 100 mesh, 12.0, 2.90.
	Magnetite in granite with limestone and dolomite.	Type or Constituents***	Granite.	P.C. actinolite, calcite. M.C. talc, quartz, orthoclase, muscovite, richterite, selenite, biotite.
	This operation was closed early in 1977 as a result of exhaustion of ore reserves.	Current or Potential Use	Aggregate for construction and for concrete. Research on the use of this rock in concrete is being done in CANMET laboratories.	Studies conducted at CANMET laboratories indicate that this material is satisfactory for dry-pressed, fired-brick manufacture.
15. Iron Ore Company of Canada, Shefferville and Sept-Iles.	Open pit - iron (Shefferville), ore is shipped to Sept-Iles for milling and processing.	Tonnage**	175 million cu yd (12 million cu yd/year).	1.5 million tpy.
	Mill capacity - 24,000 tpd, crushing, grinding, flotation, pelletizing.	Size, pH, Sp Gr	Variable, up to 3 ft.	99% minus 100 mesh.
	Chemical and clastic sediments of Labrador Trough. Rock types include iron formation, quartzite, and shales. Ore consists of iron oxides (hematite and goethite/limonite) with minor magnetite, quartz, kaolinite, and iron silicates.	Type or Constituents***	Low grade iron formation (<40% Fe, > 30% SiO_2), clays and shales.	P.C. quartz, clay M.C. kaolinite
		Current or Potential Use	Low grade iron-ore formation used as railroad ballast. Alumina rich rock may be of interest as source of alumina.	Studies have been made relative to the use of fine-grained hematite and limonite as paint pigments, and of clay for ceramic manufacture.

.....Table cont'd
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TABLE 4 (cont'd)

Mineral Wastes - Iron Ore Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
16. Quebec Cartier Mining Company, Mines at Gagnon, Mount Wright and Fire Lake; concentrators at Lac Jeannine and Mount Wright.	Open pit - iron. Mill capacity - 8 million tpy (Lac Jeannine), 18 million tpy (Mount Wright); autogenous grinding followed by spiral concentration.	Tonnage** Size, pH, Sp Gr	78 million tons (4.3 million tpy, Gagnon open pit). 55% + 12 in., 30% - 12, + 4 in., 15% - 4 in.	178 million tons (10 million tpy, Lac Jeannine concentrator). 70% - 20 mesh, 7.3, 2.83.
	Specular hematite - quartz mixture with minor mica and amphiboles.	Type or Constituents***	Quartz, gneiss, augengneiss, dolomite marble.	P.C. quartz (88%), hematite (11%). M.C. mica and amphiboles.
	Note: Gagnon open pit expected to close 1976/77 due to exhaustion of ore reserves. Fire Lake ore will be processed in Lac Jeannine concentrator.	Current or Potential Use	Construction and road work.	Aggregate in concrete and asphalt. Recovery of contained iron currently under study.
17. Quebec Iron and Titanium Corporation, Lac Tio and Tracy.	Open pit - iron and titanium (Lac Tio - Lac Allard area). Mill capacity - 2 million tpy (Tracy); crushing, grinding, heavy media spiral and cyclone concentration.	Tonnage** Size, pH, Sp Gr	Large (2 million tpy). Minus 3 ft.	Minor (240,000 tpy). Cyclone tailings, 50% + 100 mesh; 6.2, 3.96; Spiral tailings, 95% + 100 mesh.
	Ilmenite and hematite in anorthosite	Type or Constituents***	Anorthosite plus low grade ilmenite.	P.C. plagioclase, ilmenite. M.C. hematite (10%), ilmenite (6%).
		Current or Potential Use	Rock dump disposal.	Tailings are being processed at plant at Varennes for recovery of roofing granule material (25%); remainder could be utilized as aggregate or filler in asphalt and concrete.

.....Table cont'd
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TABLE 4 (cont'd)

Mineral Wastes - Iron Ore Operations

* Locations noted in Figure 1.

** Tonnage accumulated:

large	-	greater than 10 million.
substantial	-	1 to 10 million.
small	-	less than 1 million.
minor	-	less than 100,000.

*** P.C. - principal constituents, 10% or greater.
M.C. - minor constituents, less than 10%.

Note 1. Where determined, the pH of mill tailings is shown by a two digit number, and Sp Gr by a three digit number, following size designation in column 5 - Mill Tailings.

Note 2. Where information is not reported, some indication of the composition and nature of waste rock and/or mill tailings may be obtained by referring to column 2 - Type of Operation, Geology and Ore Mineralogy.

TABLE 5

Mineral Wastes - Precious Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
18. Agnico-Eagle Mines Ltd., Joutel Twp.	Underground mine - gold and silver (minor). Mill capacity - 1,000 tpd; crushing, grinding, sizing, flotation, cyanidation.	Tonnage**	Minor (30 to 50,000 tpy).	800,000 (300,000 tpy).
		Size, pH, Sp Gr	100% minus 12 in., average size 3 to 4 in.	90% minus 400 mesh.
	Volcanic and sedimentary rocks with pyrite; gold included within pyrite grains.	Type or Constituents***	Altered rhyolite, highly sericitized, talcose and schistose, 60% SiO_2.	
		Current or Potential Use	Tailing dam and road construction, yard fill.	Tailings pond disposal.
19. Camflo Mines Ltd., Malartic.	Underground mine - gold. Mill capacity - 1,250 tpd; crushing, grinding, sizing, cyanidation.	Tonnage**	Small (25,000 tpy).	4 million (450,000 tpy).
		Size, pH, Sp Gr	12 in. to fines.	85% minus 200 mesh, 9.0, 2.75.
	Gold associated with pyrite in fault zones in volcanic rocks and in a syenite porphyry intrusive.	Type or Constituents***	Feldspar porphyry and volcanic rock.	P.C. feldspar. M.C. quartz, biotite, fluorite, magnetite, ankerite, calcite, chlorite, sericite.
		Current or Potential Use	Mine backfill and road construction.	Tailings pond disposal.

.....Table cont'd
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TABLE 5 (cont'd)

Mineral Wastes - Precious Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
20. East Malartic Mines Ltd., Fournier Twp., Malartic.	Underground mine - gold. Mill capacity - 1,700 tpd; crushing, grinding, sizing. Gold occurs with quartz and pyrite in shatter zones in syenite and diorite.	Tonnage**	Minor (12,000 tpy).	550 acres (600,000 tpy).
		Size, pH, Sp Gr	12 to $1\frac{1}{2}$ in.	95% minus 150 mesh, 9.3, 2.76.
		Type or Constituents***	Greywacke.	P.C. quartz, feldspar. M.C. calcite, pyrite, biotite, gold.
		Current or Potential Use	Road maintenance and tailings dam construction.	Tailings pond disposal; 125 acres or over 10 million tons of old tailings have been successfully revegetated.
21. Lamaque Mining Co. Ltd., Bourlamaque Twp., Val d'Or.	Underground mine - gold. Mill capacity - 2,000 tpd; crushing, grinding, cyanidation. Gold occurs in quartz zones in granodiorite and quartz diorite intrusive.	Tonnage**	2 million (25,000 tpy).	18 million (350,000 tpy).
		Size, pH, Sp Gr	5 in. to fines.	90% minus 100 mesh.
		Type or Constituents***		P.C. quartz (60%), other silicates (25%), carbonates, (10%), pyrite (10%). M.C. mica.
		Current or Potential Use	Mine backfill.	Mine backfill, tailings pond disposal.

.....Table cont'd
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TABLE 5 (cont'd)

Mineral Wastes - Precious Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
22. Sigma Mines (Quebec) Ltd., Val d'Or.	Underground mine - gold. Mill capacity - 1,400 tpd; crushing, grinding, cyanidation. Gold occurs in quartz veins in porphyry and volcanic rocks.	Tonnage**	Small (25,000 tpy).	300 acres (500,000 tpy).
		Size, pH, Sp Gr	6 in. to fines.	60% minus 200 mesh, 9.0, 2.77.
		Type or Constituents***	Diorite, porphyry and volcanics.	P.C. quartz, tourmaline, calcite, chlorite, plagioclase, feldspar. M.C. epidote, sericite, muscovite, biotite, hornblende, pyroxene.
		Current or Potential Use	Road and tailings dike construction.	Mine backfill.

* Locations noted in Figure 1.

** Tonnage accumulated: large - greater than 10 million.
substantial - 1 to 10 million.
small - less than 1 million.
minor - less than 100,000.

*** P.C. - principal constituents, 10% or greater.
M.C. - minor constituents, less than 10%.

Note 1. Where determined, the pH of mill tailings is shown by a two digit number, and Sp Gr by a three digit number, following size designation in column 5 - Mill Tailings.

Note 2. Where information is not reported, some indication of the composition and nature of waste rock and/or mill tailings may be obtained by referring to column 2 - Type of Operation, Geology and Ore Mineralogy.

TABLE 6

Mineral Wastes - Industrial Minerals Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
23a. Asbestos Corporation Ltd., British Canadian Mine #1 & #2, Black Lake.	Open pit mine - chrysotile asbestos. Mill capacity - 13,000 tpd (total); crushing, screening, aspiration.	Tonnage**	Large (14 million tpy).	Large (3.8 million tpy).
		Size, pH, Sp Gr	Plus 5 in.	Minus ½ in.
		Type or Constituents***	Serpentine rock, dark green to black, massive, with narrow veinlets of asbestos.	P.C. non-fibrous serpentine and associated minerals, 5 to 10% short asbestos fibres. (MgO - 40%, SiO_2 - 38%). M.C. (Fe_2O_3 - 7%, Ni - 0.25%, Cr - 0.5%, Al - 0.7%).
		Current or Potential Use	Road fill, may be used as mine backfill.	Currently used as road fill and in asphalt. Potentially of interest as source of short asbestos fibre, nickel, and chromium. May be useful in manufacture of bricks, mineral wool, fertilizers, and as concrete aggregate and mineral filler material.
23b. Asbestos Corporation Ltd., Normandie Mine, Thetford Mines, Vimy Ridge.	Open pit - chrysotile asbestos. Mill capacity - 7,500 tpd; crushing, screening, aspiration.	Tonnage**	Large (700,000 tpy).	Large (2.1 million tpy).
		Size, pH, Sp Gr	Plus 5 in.	Minus ½ in.
		Type or Constituents***	Serpentine rock, dark green to black, massive, with narrow veinlets of asbestos.	P.C. non-fibrous serpentine and associated minerals, 5 to 10% short asbestos fibres. (MgO - 40%, SiO_2 - 38%). M.C. (Fe_2O_3 - 7%, Ni - 0.25%, Cr - 0.5%, Al - 0.7%).
		Current or Potential Use	Road fill, may be used as mine backfill.	Currently used as road fill and in asphalt. Potentially of interest as source of short asbestos fibre, nickel, and chromium. May be useful in manufacture of bricks, mineral wool, fertilizer, and as concrete aggregate and mineral filler material.

.....Table cont'd
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TABLE 6 (cont'd)

Mineral Wastes - Industrial Minerals Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
24. Bell Asbestos Mines Ltd., Thetford Mines.	Underground mine - chrysotile asbestos. Mill capacity - 3,000 tpd; crushing, screening, aspiration.	Tonnage**	Nil	Large (900,000 tpy).
		Size, pH, Sp Gr		Minus ½ in.
		Type or Constituents***		P.C. non-fibrous serpentine and associated minerals (MgO + SiO_2). M.C. iron, nickel, chromium.
		Current or Potential Use		Backfill and tailings pond disposal.
25. Canadian Johns-Manville Co. Ltd., Jeffrey Mine, Asbestos.	Open pit - chrysolite asbestos. Mill capacity - 35,000 tpd; crushing, screening, aspiration. Orebody occurs in a highly serpentinized periodotite of Lower Ordovician age. Cross fibre chrysotile forms the bulk of the ore (90%); slip fibre and mass fibre chrysotile also occur. The two main serpentine minerals are lizardite and antigorite.	Tonnage**	Large (25 million tpy).	Large (9 million tpy).
		Size, pH, Sp Gr	Minus 4 ft.	Minus 1 in. to dust; 20% minus 65 mesh.
		Type or Constituents***	Serpentine rock, dark green to black, massive, with narrow veinlets of asbestos.	P.C. serpentine (lizardite and antigorite) M.C. magnetite, brucite, awaruite (iron-nickel), chromite.
		Current or Potential Use	Waste rock dump.	Pilot plant studies have demonstrated technical feasibility of recovering nickel; however, process not economic at present. Potential uses for tailings include - fertilizer additive, additive in concrete block manufacture, source of magnesium and nickel.

.....Table cont'd
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TABLE 6 (cont'd)

Mineral Wastes - Industrial Minerals Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy		Mineral Wastes	
			Rock	Mill Tailings
26. Carey-Canadian Mines Ltd., East Broughton.	Open pit mine - chrysotile asbestos. Mill capacity - 6,000 tpd; crushing, screening, aspiration.	Tonnage**	64 million (4 million tpy).	24 million tons (1.5 million tpy).
		Size, pH, Sp Gr	Minus 4 ft.	Minus ¼ in., 50% minus 35 mesh.
		Type or Constituents***	Schist, quartzite, quartz.	P.C. serpentine. M.C. magnetite, nickel sulphides.
		Current or Potential Use	Waste rock dump.	Investigation to recover iron demonstrated technical feasibility but process not economic. Wet processing methods could be utilized to recover short fibre which could be used as reinforcing or filler material in concrete and plastics.
27. Lake Asbestos of Quebec Ltd., Black Lake Mine, Black Lake.	Open pit - chrysotile asbestos. Mill capacity - 9,000 tpd; crushing, screening, aspiration. Chrysotile veins occur in serpentinized peridotite (harzburgite).	Tonnage**	Large (9.5 million tpy).	Large (4.65 million tpy).
		Size, pH, Sp Gr	Minus 5 ft.	Minus 4 in.
		Type or Constituents***	Barren peridotite, granitic and talc-magnesite rocks.	P.C. serpentinized peridotite. M.C. short chrysotile fibre, brucite, magnetite, awaruite (iron-nickel).
		Current or Potential Use	Rock dump, some used as fill material.	Tailings disposal dumps. Research undertaken on the recovery of short fibre, iron, nickel, and magnesium indicated non feasibility on economic basis.

.....Table cont'd
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TABLE 6 (cont'd)

Mineral Wastes - Industrial Minerals Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
28. Baker Talc Ltd., Potton Twp., South Bolton.	Underground mine - talc. Mill capacity - 150 tpd; crushing, grinding, sizing, flotation. Talc occurs in serpentinized peridotite.	Tonnage**	5,000 (1,000 tpy).	10,000 (4,000 tpy).
		Size, pH, Sp Gr	12 in. to dust size.	85% minus 325 mesh, 8.4, 3.03.
		Type or Constituents***	Biotite-muscovite-quartz schist.	P.C. ferruginous magnesite, talc. M.C. nickeliferous pyrrhotite.
		Current or Potential Use	Fill.	Could be used to prevent sticking of prills in fertilizer and to add magnesia. May also be used as an inert filler material.
29. Baskatong Quartz Products Ltd., Gatineau County, Grand Remous.	Open pit - quartz. Mill capacity - 350 tpd; crushing, sizing. Massive quartz formation.	Tonnage**	100,000 (20,000 tpy).	Nil
		Size, pH, Sp Gr	12 in. and smaller.	
		Type or Constituents***	Siliceous wall rock.	
		Current or Potential Use	Waste rock dump.	

.....Table cont'd
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TABLE 6 (cont'd)

Mineral Wastes - Industrial Minerals Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
30. Broughton Soapstone and Quarry Ltd., St. Pierre-de-Broughton.	Open pit - talc, soapstone. Mill capacity - 150 tpd; grinding, sizing. Serpentized peridotite.	Tonnage**	Minor (1,500 tpy).	Nil
		Size, pH, Sp Gr	12 in. and smaller.	
		Type or Constituents***		
		Current or Potential Use	Backfill.	
31. Dresser Industries Canada, Ltd., Canadian Refractories Ltd., Kilmar.	Underground mine - dolomitic magnesite. Mill capacity - 900 tpd; crushing, sizing, heavy-media beneficiation, sintering. Dolomitic magnesite ore occurs as steeply dipping lens-shaped bodies in highly metamorphosed Precambrian sediments of the Grenville series.	Tonnage**	Minor (5,000 tpy).	Small (3,000 tpy).
		Size, pH, Sp Gr	6 in. and smaller.	100% minus 150 mesh, 9.2, 2.88.
		Type or Constituents***	Altered limestone, serpentine, diopside, monzonite.	P.C. dolomitic magnesite and limestone, serpentine. M.C. micaceous limestone.
		Current or Potential Use	Road construction and backfill also could be used as aggregate in concrete.	Current and potential use as a source of refractory grade magnesia.

.....Table cont'd
Footnotes on p 39

TABLE 6 (cont'd)

Mineral Wastes - Industrial Minerals Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
32. St. Lawrence Columbium and Metals Corp., Oka.	Open pit and underground mines - columbium oxide. Mill capacity - 2,200 tpd; crushing, grinding, flotation, magnetic separation. Alkaline igneous intrusive containing pyrochlore and many minor minerals. Product pyrochlore concentrate containing columbium (niobium) in the form of Cb_2O_5.	Tonnage**	2.7 million tons (100,000 tpy).	4 million tons (700,000 tpy).
		Size, pH, Sp Gr	5 ft. down, 80% minus 2 ft.	50% minus 100 mesh, 8.5, 2.83.
		Type or Constituents***	Carbonatite (60%), quartz (40%), pyroxene, nepheline.	P.C. carbonatite (75%), silicates (18%). M.C. apatite (5%), pyrite, magnetite, mica.
		Current or Potential Use	Rock dump disposal, small tonnages used for road building.	Small tonnages of calcite from mill tailings are sold for agricultural purposes and as soil neutralizer. Potential uses are as neutralizer for acid effluents and as filler material.
33. Union Carbide Canada Ltd., Melocheville	Open pit - silica. Mill capacity - 1,200 tpd, crushing, sizing. Sandstone.	Tonnage**	40 to 45 tons per day.	
		Size, pH, Sp Gr	100% minus 1 in.	
		Type or Constituents***	Impure sandstone.	
		Current or Potential Use	Currently used in cement manufacture.	

.....Table cont'd
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TABLE 6 (cont'd)

Mineral Wastes - Industrial Minerals Operations

* Locations noted in Figure 1.

** Tonnage accumulated:

large	- greater than 10 million.
substantial	- 1 to 10 million.
small	- less than 1 million.
minor	- less than 100,000.

*** P.C. - principal constituents, 10% or greater.
M.C. - minor constitutents, less than 10%.

Note 1. Where determined, the pH of mill tailings is shown by a two digit number, and Sp Gr by a three digit number, following size designation in column 5 - Mill Tailings.

Note 2. Where information is not reported, some indication of the composition and nature of waste rock and/or mill tailings may be obtained by referring to column 2 - Type of Operation, Geology and Ore Mineralogy.

TABLE 7

Mineralogy - Mill Tailing Samples

Sample* Identification	Constituents		
	Greater than 20%	10 to 20%	Less than 10%
Base Metals			
1 (S-1)	quartz	pyrite, chlorite, calcite, epidote	plagioclase, mica
1 (S-2)	quartz	chlorite, pyrite calcite, epidote	plagioclase, mica
2	plagioclase	amphibole	quartz, K-feldspar, pyrite, magnetite, mica, chlorite
3	quartz, garnet	pyroxene	K-feldspar
4	quartz, pyrite	--	plagioclase, mica, chlorite
5	quartz, K-feldspar, plagioclase	--	amphibole, mica
6	quartz, pyrite	mica	plagioclase
7	quartz, pyrite	magnetite	pyrrhotite, calcite, chlorite, plagioclase, mica
9	quartz	sulphur	chlorite, pyrrhotite, magnetite goethite, pyrite
10	pyrite, quartz	siderite, magnetite	calcite, plagioclase
13	quartz, pyrite	--	plagioclase, mica chlorite
Iron			
14	amphibole, quartz	serpentine, talc, mica	K-feldspar, plagioclase
15a(S-1)	quartz, goethite	hematite	--
15a(S-2)	quartz, hematite	--	--

.....Table cont'd
Footnotes on p 41

TABLE 7 (cont'd)

Mineralogy - Mill Tailing Samples

Sample* Identification	Constituents		
	Greater than 20%	10 to 20%	Less than 10%
15a(S-3)	kaolin, hematite	--	goethite
15a(S-4)	goethite, hematite	--	kaolin, quartz
16	quartz, hematite	--	mica
17 (S-1)	plagioclase, ilmenite, hematite	--	mica
17 (S-2)	ilmenite, hematite	plagioclase	mica
Precious Metals			
19	quartz, plagio-clase	--	muscovite, calcite, dolomite, K-feldspar
20	quartz, plagio-clase	calcite, K-feldspar	mica, talc
22	quartz, plagio-clase	--	pyrite, mica, chlorite
Industrial Minerals			
23a	serpentine	olivine	brucite, magnetite, pyroxene, plagio-clase
25	serpentine	--	magnetite, olivine
28	magnesite, dolo-mite	talc	chlorite
31	dolomite, magne-site	serpentine	calcite, quartz
32	calcite	apatite	dolomite, quartz, mica

* Numbers correspond to those noted in Tables 2 to 9, and to locations on map, Figure 5.

(S-1), (S-2), etc. - Samples 1, 2, etc.

TABLE 8

Semi-Quantitative Spectrochemical Analysis* - Mill Tailing Samples

Sample** Ident.	Element Per Cent																		
	Si	Fe	Al	Ca	Mg	Na	Mn	Pb	Sn	Cr	Cu	Zr	Ni	Co	Ba	Sr	Ag	Ti	Zn
Base Met.																			
1(S-1)	P.C.	P.C.	P.C.	P.C.	P.C.	0.60	0.04	0.04	n.d.	0.02	0.10	n.d.	0.04	0.02	n.d.	n.d.	n.d.	n.d.	n.d.
1(S-2)	"	"	0.40	"	"	0.53	0.02	0.04	"	0.01	0.05	"	0.02	0.01	"	"	"	"	"
2	"	"	P.C.	"	"	P.C.	0.02	0.02	"	n.d.	0.06	0.01	0.06	0.01	"	"	"	"	"
3	"	"	"	"	"	0.62	0.08	n.d.	"	0.02	0.09	0.01	0.02	n.d.	0.05	"	"	"	"
4	"	"	"	0.40	0.43	n.d.	0.02	"	"	"	n.d.	0.01	0.02	"	n.d.	"	"	"	0.96
5	"	"	"	P.C.	P.C.	0.65	0.03	0.07	"	0.03	0.06	0.01	0.02	"	0.11	"	"	"	n.d.
6	"	"	"	0.68	"	n.d.	0.08	0.10	"	0.02	0.05	0.01	0.02	"	n.d.	"	0.01	"	P.C.
7	"	"	0.27	P.C.	"	"	0.12	n.d.	"	n.d.	0.08	0.01	0.02	0.01	"	"	0.01	"	"
9	"	"	0.32	0.27	"	0.25	0.02	0.05	"	0.02	0.07	0.01	0.02	0.01	"	"	n.d.	"	0.23
10	"	"	0.36	P.C.	"	"	0.15	0.04	0.01	n.d.	0.07	0.01	0.02	0.01	"	"	0.01	"	P.C.
13	"	"	P.C.	0.76	"	0.50	0.06	0.04	n.d.	0.02	0.06	0.01	0.02	n.d.	0.78	"	n.d.	"	n.d.
Iron																			
14	P.C.	P.C.	P.C.	P.C.	P.C.	P.C.	0.01	n.d.	n.d.	n.d.	0.11	0.01	n.d.	0.01	n.d.	n.d.	n.d.	n.d.	n.d.
15a(S-1)	"	"	0.36	0.01	0.02	n.d.	0.01	0.02	"	"	n.d.	0.01	0.03	0.01	"	0.01	"	"	"
15a(S-2)	"	"	0.10	0.01	0.01	"	0.02	0.05	"	"	0.02	0.01	0.02	n.d.	"	n.d.	"	"	"
15a(S-3)	"	"	P.C.	0.01	0.04	"	0.01	0.05	"	0.04	0.01	0.01	0.01	"	"	"	"	"	"
15a(S-4)	0.75	"	0.22	0.01	0.01	"	0.01	0.04	"	n.d.	0.01	0.01	0.01	"	"	"	"	"	"
16a	P.C.	"	0.34	0.50	0.24	0.06	0.01	0.03	"	"	0.02	0.01	0.10	"	"	"	"	"	"
17(S-1)	"	"	P.C.	P.C.	P.C.	P.C.	0.01	n.d.	"	0.02	0.09	0.01	n.d.	"	"	"	"	P.C.	"
17(S-2)	"	"	"	n.d.	"	"	0.01	"	"	0.04	0.06	0.01	"	"	"	"	"	"	"
Prec. Met.																			
19	P.C.	P.C.	P.C.	P.C.	P.C.	P.C.	0.02	0.03	n.d.	0.03	0.03	0.01	0.12	n.d.	0.09	0.07	n.d.	n.d.	n.d.
20	"	"	"	"	"	"	0.02	0.04	"	0.04	0.02	0.01	0.04	0.01	0.08	0.10	"	"	"
22	"	"	"	"	"	0.91	0.08	0.02	"	0.03	0.02	0.01	0.01	n.d.	n.d.	n.d.	"	"	"
Ind. Min.																			
28	P.C.	0.55	0.07	0.50	P.C.	n.d.	0.01	0.02	0.01	0.07	0.05	n.d.	0.04	n.d.	n.d.	n.d.	n.d.	0.01	n.d.
31	0.43	0.20	n.d.	P.C.	"	0.05	0.01	0.02	n.d.	n.d.	0.02	"	n.d.	"	"	0.05	"	n.d.	"
32(S-1)	P.C.	0.68	0.11	"	"	0.24	P.C.	0.03	"	"	n.d.	"	"	"	"	0.61	"	0.02	"
33(S-2)	"	P.C.	n.d.	"	"	0.10	"	n.d.	"	"	"	"	"	"	"	0.70	"	n.d.	"

* principal elements, additional information available on request.
** numbers correspond to those noted in Tables 2 to 9, and to locations on map, Figure 5.
P.C. principal constituent, one per cent or greater.
n.d. not detected, i.e., below the lowest limit of detection by this technique.
Prec. Met. precious metals.
Ind. Min. industrial minerals.

(S-1), (S-2), etc. - Samples 1, 2, etc.

TABLE 9

Chemical Analyses - Mill Tailing Samples

Sample* Identification	Compound - Per cent							
	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	S	TiO_2	LOI
Base Metals								
1(S-1)	40.08	18.71	18.84	6.86	3.20	3.31	-	6.59
1(S-2)	39.60	18.45	18.58	6.66	2.73	3.13	-	6.00
2	48.57	18.87	13.54	6.44	3.35	1.98	-	1.94
3	62.23	6.72	7.35	14.80	3.91	11.54	-	1.30
4	40.62	24.12	14.50	0.81	2.61	16.42	-	13.25
5	59.22	8.25	17.68	4.86	3.54	0.10	-	0.92
6	48.39	18.93	13.82	1.22	2.70	13.07	-	11.18
7	27.07	43.34	5.75	3.47	5.11	16.48	-	11.65
9	33.06	37.49	6.86	0.78	1.01	11.32	-	18.84
10	21.97	44.19	4.18	3.56	3.60	21.18	-	16.37
13	45.58	17.70	13.67	1.03	5.54	12.14	-	10.79
Iron								
14	49.75	12.86	5.88	5.38	19.04	2.75	-	5.20
15a(S-1)	35.79	53.44	5.66	0.20	0.19	0.01	-	4.80
15a(S-2)	42.48	54.43	4.15	0.19	0.09	0.01	-	1.45
15a(S-3)	30.86	26.53	33.91	0.25	0.22	0.01	-	11.83
15a(S-4)	9.66	70.67	10.73	0.23	0.09	0.01	-	9.52
16a	86.39	10.22	1.58	0.87	0.36	0.02	-	0.45
17(S-1)	44.03	13.98	21.42	6.58	2.46	0.22	6.44	1.08
17(S-2)	14.12	44.51	9.34	2.35	4.08	0.34	26.00	1.10
Precious Metals								
19	61.43	5.99	15.56	4.12	2.15	1.32	-	1.08
20	59.65	5.71	14.21	4.44	5.57	0.99	-	3.05
22	52.99	6.64	18.35	6.00	3.91	0.62	-	4.59
Industrial Minerals								
28	22.30	8.98	4.59	3.02	32.83	0.38	-	26.13
31	8.00	0.74	0.53	11.86	36.34	0.14	-	41.01
32(S-1)	3.98	2.72	0.60	50.00	1.71	0.51	-	36.18
32(S-2)	5.90	4.12	1.40	46.78	2.02	0.68	-	33.35

* Numbers correspond to those noted in Tables 2 to 8, and to locations on map, Figure 5.

(S-1), (S-2), etc. - Samples 1, 2, etc.

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