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MINERAL WASTE RESOURCES OF CANADA REPORT NO. 3 – MINING WASTES IN BRITISH COLUMBIA

R.K. COLLINGS

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MINERAL WASTE RESOURCES OF CANADA
REPORT NO. 3 - MINING WASTES IN BRITISH COLUMBIA*

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 million tonnes. Only a small portion of this is used because of such factors as remote location, low quality and lack of information on the nature of these wastes and possible applications. Current applications include road construction and maintenance, railroad ballast, smelter flux, and mine backfill. Uses being studied by CANMET researchers and others include the recovery of contained metals and minerals, the production of concrete and construction aggregate, the manufacture of bricks, blocks, and mineral wool insulation, and as a soil additive.

This report provides background information on waste rock and mill tailings in British Columbia, where more than 300 million tonnes of such wastes are produced annually. Data on the occurrence, mineralogy, petrography, physical and chemical characteristics of wastes from twenty-seven operating mines are provided in tabular form for three principal types of mines - metal, non-metallic or industrial mineral, and coal. Placer gold mines are not included. Potential uses for certain wastes are noted along with relevant research.

The development of viable uses for mineral wastes is a complex problem that requires the cooperation of producers and potential consumers at all stages. Answers to this problem, although often difficult to find, will help conserve Canada's non-renewal mineral resources and aid in reducing pollution associated with some wastes.

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* Project MRP-4.3.5.0.01 - Identification, Characterization, Evaluation of Primary Mineral Wastes.

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RESSOURCES CANADIENNES EN REBUTS MINERAUX
RAPPORT NO 3 - LES REBUTS MINERAUX EN COLOMBIE BRITANNIQUE*

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 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 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, 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 de la Colombie Britannique dont la production annuelle s'élève à environ 300 millions de tonnes. Les données concernant l'abondance, la minéralogie et les propriétés physiques et chimiques des déchets des vingt-sept mines en exploitation sont disposées en tableaux pour les trois principaux types de mine: métaux, minéraux non-métalliques ou industriels et charbon. Les exploitations placériennes pour la récupération de l'or ne sont pas incluses. Les usages possibles de certains déchets et la recherche pertinente sont mentionnés.

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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* Project MRP-4.3.5.0.01 - Identification, caractérisation et évaluation des minéraux résiduels primaires.

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TABLE OF CONTENTS

TABLES

FIGURES

INTRODUCTION

Canada has large resources of most metallic and non-metallic minerals. These resources 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 farther afield, often in remote areas, for new orebodies. Simiarly, 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 province of British Columbia.

Mining wastes are being generated and accumulated at a rate in excess of 800 million tonnes per year in Canada. British Columbia accounts for more than 300 million tonnes. 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. They 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 from tailings at abandoned mines, of using these wastes as raw material for manufacturing various products, e.g., bricks and 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 more 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 determine the magnitude and nature of mineral waste resources
- to investigate the technical feasibility of using certain wastes for various products, and of recovering the contained minerals
- to encourage further research by industry and government.

As part of this study, five preliminary reports of sources of mineral wastes in Canada were prepared in 1972[1,2,3,4,5]. These internal unpublished documents were used as a basis for research in the field of mineral waste utilization by a small group of CANMET scientists. Although 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 British Columbia," is the third 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. The second, "Mineral Wastes Resources of Canada, Report No. 2 - Mining Wastes in Quebec," CANMET Report 77-55, was published in 1977. This latter report is also available in French as CANMET Rapport 77-55F, "Ressources Canadiennes en Rebuts Minéraux, Rapport No. 2 - Les Rebuts Mineraux au Québec." Reports on mining wastes in the Prairie Provinces and in the Atlantic Provinces are scheduled for 1979 and 1980. These reports are concerned with operating mines only; wastes from certain abandoned mines and from the metallurgical and chemical industries also are of interest and will be documented in future reports.

MINERAL WASTES

The preliminary reports[1,2,3,4,5] contained a tabulation on mineral wastes by types. This is reproduced in modified form in Table 1. Wastes are divided into four general groups. Those in the first two are large-volume, low-grade mixtures of minerals and, as such, are usually unattractive for further economic exploitation. 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 disposal is best solved by long-term, planned stabilization and landscaping. Disposal areas

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 metals and minerals and raw material for the manufacture of bricks and blocks, soil fertilizers and additives, mineral fillers, chemicals, etc.	

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. These wastes may contain significant amounts of metals and minerals or they could represent 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.

MINING WASTES IN BRITISH COLUMBIA

For ease of reference, information on mining wastes in British Columbia is presented in Tables 3 to 8. 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 waste produced. Tonnage estimates and current and potential uses are noted. In addition, chemical, spectrochemical, and mineralogical data are given for 21 samples of mill tailings. Sand and gravel pits, placer gold operations, and stone and crushed stone quarries have not been included although waste fines and coarse material may be available for reuse at such operations. As an aid to the reader, wastes are separated into three general categories based on origin as follows:

Metal Mining Operations	(Table 3)
Industrial Mineral Mining Operations	(Table 4)
Coal Mining Operations	(Table 5).

Data for Tables 3 to 5 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 British Columbia[2] and from the technical press. Data from these tabulations should be studied and evaluated with that from Table 6, Mineralogy - Mill Tailing Samples; Table 7, Semi-Quantitative Spectrochemical Analyses - Mill Tailing Samples; and Table 8, Chemical Analyses - Mill Tailing Samples, to arrive at a fuller appreciation of the nature and potential usefulness of these wastes. Data in Tables 6, 7 and 8 were developed by CANMET staff using representative samples of mill tailings obtained from operating companies.

The 27 mining operations considered are identified by numbers 1 to 27 in Tables 2 to 8 and on the map, Fig. 4.

Metal Mines

A variety of metallic ores are mined in British Columbia including copper, molybdenum, lead, zinc, iron, silver, and gold. Most mines are located in the south although there are several in the central and western regions of the province.

Waste rock from underground metal mines does not usually represent a large quantity, except that produced during development work. This rock is used underground as backfill but it may be brought to the surface for use in road construction. Waste rock from open pit mines, by contrast, may equal or exceed the amount of ore mined. This rock is stockpiled but may find limited local use in road construction and as construction aggregate. Large volume uses normally are few because of the

Fig. 1. Open pit and waste rock piles of Craigmont Mines Ltd. at Merritt. (Photo by George Hunter).

remote location of many of the mine sites. However, there are exceptions. Waste rock from a former open pit iron mine on Texada Island is sized by Ideal Cement Company and barged to the Vancouver area where it is sold for such purposes as railroad ballast, riprap and concrete aggregate. Float rock from Cominco's Sullivan concentrator at Kimberley is regularly used as railroad ballast in British Columbia and the Prairie Provinces. Waste rock, averaging 0.15 to 0.25% copper, is now being used as mill feed by the Phoenix Copper Division of Granby Mining Corporation near Grand Forks following virtual exhaustion of ore reserves in the open pit.

Mill tailings production at metal mining operations amounts to many millions of tons per year. These finely ground tailings may contain large amounts of pyrite and pyrrhotite which are potentially recoverable for conversion to sulphuric acid, for example, as currently practised by Cominco Limited at Kimberley. The impure nature and remote location of many tailings limit their use to local low-grade applications, e.g., as mine back-fill, in road maintenance and, on occasion, as smelter flux. Some mill tailings contain small but significant amounts of recoverable minerals. For example, several companies have expressed interest in the feasibility of recovering copper from old tailings in the Princeton and Grand Forks area, and Mountain Minerals Limited recovers barite for use in oil well drilling mud from abandoned base metal mine tailings near Invermere. Some tailing piles are being revegetated for use as public parks or as wildlife areas.

Current metal mining operations in British Columbia with available data on waste rock and mill tailings are noted in Table 3.

Industrial Mineral Mines

Asbestos is the chief industrial mineral produced in British Columbia, production being derived from an open pit mine at Cassiar in the most northerly section of the province. Other industrial minerals produced include limestone, silica, barite, gypsum and diatomite. These latter operations are located in the south.

Large quantities of waste rock are produced at the Cassiar open pit asbestos operations. The bulk of this is stock-piled in dumps although minor amounts are used locally as roadfill.

Asbestos tailings are of interest from the standpoint of recovering additional minerals and have therefore been studied fairly extensively. Asbestos tailings contain 5 to 10% short asbestos fibre with significant amounts of magnesium, nickel, chromium, and iron. Studies have been made on recovering the short fibre by wet processing 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[6,7,8]. Work undertaken at CANMET laboratories demonstrated the technical feasibility of producing mineral wool as well as an interesting nickel-iron co-product from asbestos mill tailings[9].

Production of waste rock and mill tailings at most of the other operating industrial mineral mines in British Columbia is relatively small. Current operations with available data on

Fig. 2. Mill tailings of Cassiar Asbestos Corporation Limited at Cassiar with mill in left background. (Photo courtesy Cassiar Asbestos Corporation)

waste rock and mill tailings are listed in Table 4.

Coal Mines

Current production of coal in British Columbia is from three open pits and one underground mine, all in the southeastern part of the province. Exploration and economic studies are being carried out on several other deposits, including the Hat Creek deposit in the soutwest. British Columbia Hydro is currently investigating the feasibility of establishing a coal-fired thermal generating plant using Hat Creek coal.

Large quantities of waste rock, principally sandstone and shale, are produced during the open pit mining of coal; significant quantities are used locally for road and dike construction but most is trucked to waste disposal sites.

Coal processing plant rejects range in size from 10 cm downward. These rejects may contain 30% or more coal and have a calorific value of 18 to 20 MJ/kg. They are of potential value for recovering metallurgical coal or, alternatively, as feed for thermal power plants. Some interest has been expressed in the feasibility of recovering the 30 to 35% alumina in coaly wastes, especially from the Hat Creek deposit, and several groups, including CANMET, are investigating this possibility. Current coal mining operations in British Columbia with available data on waste rock and mill tailings are listed in Table 5.

Additional Data

Additional data on the nature and composition of mining wastes were provided by CANMET laboratories which performed mineralogical, semi-quantitative spectrochemical,and chemical analyses.

Fig. 3. Open pit coal mining operations of Kaiser Resources Ltd. near Sparwood. (Photo by George Hunter)

on representative samples. The results are given in Tables 6, 7 and 8.

CONCLUSION

This report presents available data on the physical, chemical and mineralogical nature of mining wastes in British Columbia. 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 a potential use requirement; 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.

The author would be pleased to receive information, comments and suggestions for increasing the utilization of specific mineral wastes in British Columbia.

ACKNOWLEDGEMENTS

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8. Nickel, E.H. "Investigation of nickel content of Cassiar serpentine"; Mines Branch Report IR 71-11, 1971.

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TABLE 2

Company, Mine/Mill Location, Identification Number

Company Name, Mine/Mill Location	Identification Number
Metal Operations	
Bethlehem Copper Corporation Ltd., Highland Valley	1
Brenda Mines Ltd., Peachland	2
Canex Placer Limited, (Endako mine), Endako	3
Cominco Ltd., (Sullivan mine), Kimberley	4
Cominco Ltd., (H.B. mine), Salmo	5
Craigmont Mines Limited, Merritt	6
Dankoe Mines Ltd., Keremeos	7
Gibraltar Mines Limited, McLeese Lake	8
Granby Mining Corporation, (Phoenix Division), Phoenix	9
Granisle Copper Limited, Granisle	10
Kam-Kotia Mines Limited, (Silmonac mine), New Denver	11
Lornex Mining Corporation Ltd., Highland Valley	12
Newmont Mines Limited, (Granduc Operating Division), Stewart	13
Newmont Mines Limited, (Similkameen Division), Princeton	14
Noranda Mines Limited, (Bell Copper Division), Babine Lake	15
Noranda Mines Limited, (Boss Mountain Division), Hendrix Lake	16
Northair Mines Ltd., Bradywine	17
Tech Corporation Limited, Beaverdell	18
Utah Mines Ltd., Port Hardy	19
Westfrob Mines Limited, Tasu	20
Western Mines Limited, Myra Falls	21
Industrial Mineral Operations	
Baroid of Canada Limited, Spillimacheen	22
Cassiar Asbestos Corporation Limited, Cassiar	23
Coal Operations	
Byron Creek Collieries Limited, Corbin	24
Fording Coal Limited, Elkford	25
Kaiser Resources Ltd., Sparwood	26
Kaiser Resources Ltd., Michel	27

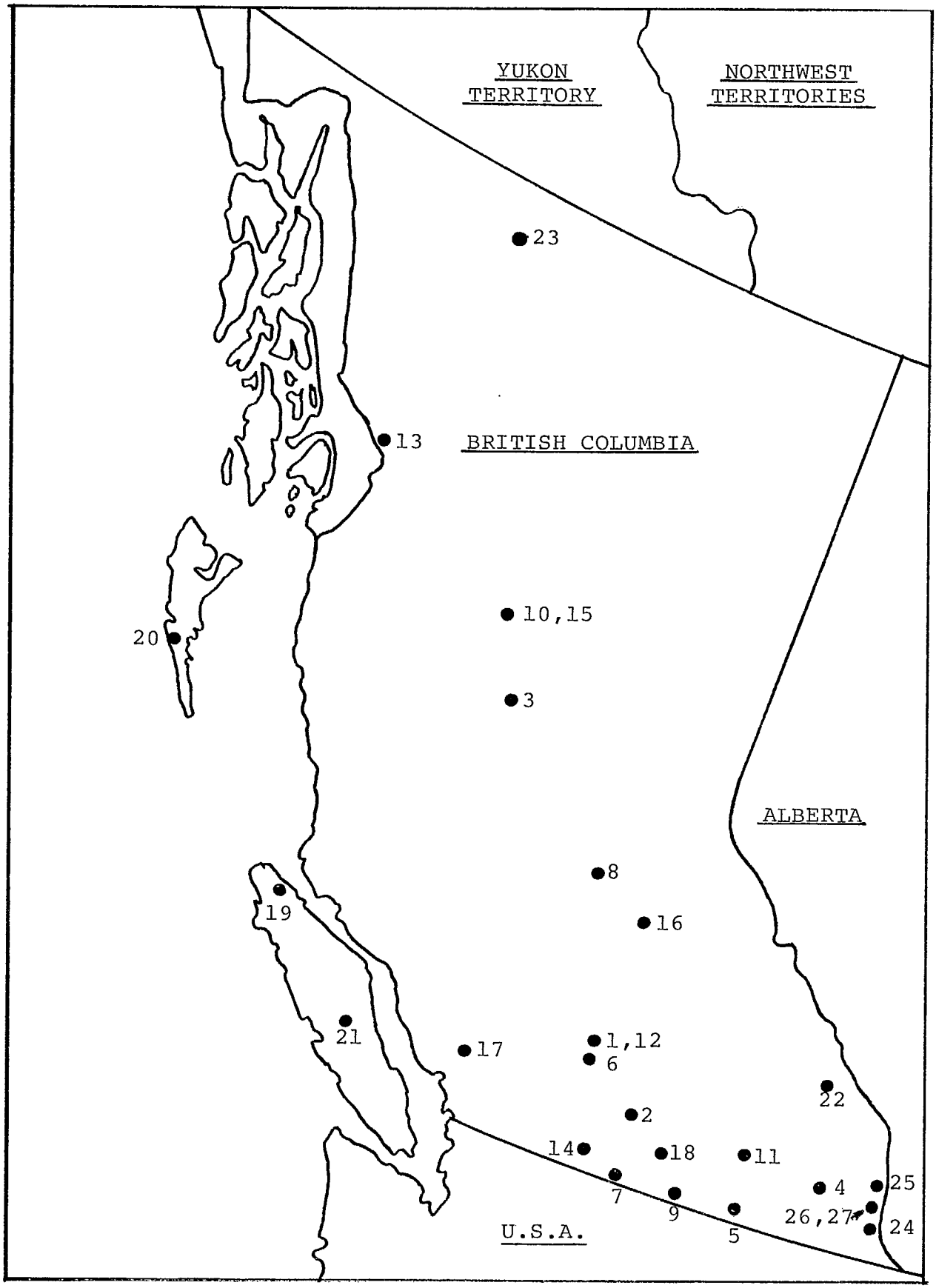

Fig. 4. Location of mining/mineral processing operations listed in Table 2.

TABLE 3

Mineral Wastes - Metal Mining Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
1. Bethlehem Copper Corp. Ltd., Highland Valley, Ashcroft.	Open pit - copper. Mill capacity - 17,000 tpd; crushing, grinding, flotation. Ore zone with copper sulphides occurs in igneous intrusive, quartz diorite, granodiorite and breccia.	Amount**	Large (13 million tpy).	Substantial (6.6 million tpy).
		Size, pH, Sp Gr		65% minus 150 µm; 8.4; 2.71.
		Type or Constituents***	Granodiorite - massive inhomogeneous rock. Coarse material, grey in colour and comprised of feldspar and quartz with lath-shaped amphibole crystals. Fine material, pale red, with disseminated mafic minerals, quartz phenocrysts and rare sulphides.	P.C. - quartz, plagioclase, mica. M.C. - chlorite
		Current or Potential Use	Rock dump disposal.	Tailings pond disposal.
2. Brenda Mines Ltd., Peachland.	Open pit - copper, molybdenum. Mill capacity - 22,000 tpd; crushing, grinding, flotation, leaching. Orebody is associated with quartz diorite intrusive; ore minerals are chalcopyrite and molybdenite, with minor pyrite and magnetite occurring as fillings within fractures.	Amount**	45 million total (4.1 million tpy).	Large (8 million tpy).
		Size, pH, Sp Gr	Pit run, minus 1 m.	55% minus 150 µm; 8.9; 2.73
		Type of Constituents***	Granodiorite - medium-grained, grey, with moderate proportion of mafic minerals, no obvious altered minerals or sulphides, (Cu-0.06%, Mo-0.01%).	P.C. - quartz, plagioclase, K-feldspar, mica. M.C. - amphibole (Cu 0.02%, Mo 0.007%, Pb 0.001%, S 0.05%, Fe 2%).
		Current or Potential Use	Rock dump disposal.	Tailings pond disposal. Ongoing research programs designed to maximize the recovery of copper and molybdenite.

.....Table cont'd
Footnotes on p.28.

TABLE 3

Mineral Wastes - Metal Mining Operations (cont'd)

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
3. Canex Placer Limited, Endako Mines Division, Endako.	Open pit - molybdenum. Mill capacity - 24,500 tpd; crushing, grinding, flotation. Ore occurs in quartz monzonite with aplite, pyrite and magnetite.	Amount**	Large.	Large (7 to 9 million tpy).
		Size, pH, Sp Gr		90% minus 150 µm.
		Type or Constituents***		
		Current or Potential Use		
4. Cominco Ltd., Sullivan mine, Kimberley.	Underground mine - zinc, lead. Mill capacity - 9,000 tpd; crushing, grinding, flotation, heavy media separation. Flotation tailings are retreated to provide an iron concentrate (48% Fe) and siliceous tailings. Ore occurs in banded sediments; pyrrhotite is dominant sulphide.	Amount**	Rock - large. Float - 810,000 tonnes	Large (1.15 million tpy). Iron tailings - 22 million tonnes (40% Fe). Siliceous tailings - 30 million.
		Size, pH, Sp Gr	Rock - 5 to 15 cm. Float - 80% minus 8 cm.	80% minus 150 µm; 5.3; 3.05
		Type of Constituents	Argillite and tourmalinized argillite - irregular fragments, dense, green to dark green, some impure quartzite.	P.C. - quartz, pyrrhotite, pyrite, chlorite, plagioclase. M.C. - mica. Siliceous tailings - 20.5% Fe, 0.55% Pb, 0.45% Zn.
		Current or Potential Use	Rock dump disposal. Float from sink-float plant is used as railroad ballast by CPR.	Pyrite for manufacture of sulphuric acid for phosphate fertilizer is recovered from flotation tailings.

.....Table cont'd
Footnotes on p.28.

TABLE 3

Mineral Wastes - Metal Mining Operations (cont'd)

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
5. Cominco Ltd., H.B. mine, Salmo area.	Underground - zinc, lead. Mill capacity - 1100 tpd; crushing, grinding, flotation.	Amount **	400,000 (27,000 tpy).	6.55 million (365,000 tpy).
		Size, pH, Sp Gr		80% minus 150 µm; 8.6; 2.99.
		Type or Constituents***		P.C. - dolomite, pyrite, tremolite. M.C. - calcite, quartz.
		Current or Potential Use	Rock dump disposal. Small quantities are used for road and yard maintenance.	Tailings pond disposal. Minor quantities have been used as a substitute for sand in Portland cement concrete.
6. Craigmont Mines Ltd., Merritt.	Underground mine - copper, magnetite; also recover stockpiled ore from former open pit copper operation. Mill capacity - 5300 tpd; crushing, grinding, flotation. Ore occurs in limestone - diorite formation with chalcopyrite, magnetite, hematite.	Amount**	Small (180,000 tpy).	Substantial (2 million tpy).
		Size, pH, Sp Gr		70% minus 150 µm; 8.9; 2.90
		Type of Constituents***	Altered rocks - variable in texture and in colour, calcareous, some types are fine-grained, inhomogeneous, others are gneissic with sulphides in disseminated grains and small veinlets.	P.C. - quartz, plagioclase. M.C. - calcite, dolomite, chlorite, K-feldspar, hematite, magnetite.
		Current or Potential Use	Rock dump disposal.	Tailings pond disposal. Stockpile of magnetite concentrate is saleable as heavy medium for coal beneficiation, if retreated.

.....Table cont'd
Footnotes on p.28.

TABLE 3

Mineral Wastes - Metal Mining Operations (cont'd)

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
7. Dankoe Mines Ltd., Keremeos.	Underground - silver, gold. Mill capacity - 135 tpd; crushing, grinding, flotation. Note: Mine ceased production in July 30, 1975, and reopened in June 1976.	Amount**	Unknown.	Unknown.
		Size, pH, Sp Gr		
		Type or Constituents***		
		Current or Potential Use		
8. Gibraltar Mines Ltd., McLeese Lake, Cariboo District.	Open pit - copper, molybdenum. Mill capacity - 36,000 tpd; crushing, grinding, flotation. Orebody associated with quartz-diorite intrusion into volcanics and meta sediments, with quartz, altered feldspar, chlorite and sulphides.	Amount**	80 million tonnes (14 million tpy).	70 million tonnes (13 million tpy).
		Size, pH, Sp Gr	Minus 15 cm.	5.5% minus 150 µm; 8.8; 2.77.
		Type of Constituents***	Quartz diorite - coarse-grained, mottled, strongly foliated. Felsic minerals comprise masses of clear quartz and soft, altered feldspar. Mafic component consists of green-black amphibole with some mica.	P.C. - quartz, plagioclase. M.C. - mica, chlorite.
		Current or Potential Use	Rock dump disposal.	Tailings pond disposal.

.....Table cont'd
Footnotes on p. 28.

TABLE 3

Mineral Wastes - Metal Mining Operations (cont'd)

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
9. Granby Mining Corp., Phoenix Copper Div., Grand Forks.	Open pit - copper, gold, silver. Mill capacity - 2500 tpd; crushing, grinding, flotation. Ore zone occurs in limestone chert and breccias; mining of new ore essentially complete; broken ore now being processed through mill.	Amount**	Large.	Large (1 million tpy).
		Size, pH, Sp Gr	Pit run, minus 1 m.	70% minus 150 µm.
		Type or Constituents***	Skarn, arkose.	P.C. - skarn. M.C. - pyrite, hematite, magnetite, calcite.
		Current or Potential Use	Rock dump disposal. Minor amounts used as gravel in road surfacing.	Tailings pond disposal.
10. Granisle Copper Ltd., Granisle.	Open pit - copper, gold, silver. Mill capacity - 12,000 tpd; crushing, grinding, flotation. Chalcopyrite, bornite in porphyry.	Amount**	Large (11 million tpy).	Substantial (5 million tpy).
		Size, pH, Sp Gr	60% minus 30 cm.	80% minus 150 µm.
		Type of Constituents***	Low-grade porphyry, andesites, volcanics.	P.C. - quartz, feldspar, biotite and kaolinite. M.C. - magnetite, pyrite, chlorite, specular hematite, limonite.
		Current or Potential Use	Rock dump disposal. Used in construction of tailings pond impoundment dams.	Tailings pond disposal.

.....Table cont'd
Footnotes on p. 28.

TABLE 3

Mineral Wastes - Metal Mining Operations (cont'd)

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
11. Kam-Kotia Mines Ltd., Silmonac mine, New Denver.	Underground mine - lead-silver, zinc-silver. Mill capacity - 135 tpd; crushing, grinding, flotation. Ore minerals - galena, sphalerite, native silver and sulphides, occur as vein formation in sedimentary rocks. Note: Ore from Silmonac mine is treated in nearby mill leased from Silvana Mines Inc.	Amount**	90,000 (13,500 tpy).	125,000 (15,000 tpy).
		Size, pH, Sp Gr	Minus 30 cm.	80% minus 75 μm; 8.1; 2.84.
		Type or Constituents***	Quartz diorite - medium grained, green or black mafic minerals, white feldspar and quartz. Many schist-coated fracture surfaces. Volcanic tuff - fine grained, dense. Quartzite - white with minor calcite and feldspar. Some fine-grained sulphide.	P.C. - quartz, mica, siderite. M.C. - sulphides
		Current or Potential Use	Used as road base material.	
12. Lornex Mining Corp. Ltd., Highland Valley.	Open pit - copper, molybdenum. Mill capacity 43,000 tpd; crushing, grinding, flotation. Host rock, Skeena quartz-diorite, intruded by pre-ore quartz porphry dyke; main ore minerals are chalcopyrite, bornite, molybdenite.	Amount**	34 million tpy.	Substantial (15 million tpy).
		Size, pH, Sp Gr	Pit run, minus 2 m.	65% minus 150 μm; 8.9; 2.71.
		Type of Constituents***	Quartz diorite - coarse-grained, homogeneous with chalky, altered feldspar, masses of grey quartz, and scattered grains of amphibole.	P.C. - quartz, plagioclase. M.C. - mica, chlorite, calcite.
		Current or Potential Use	Rock dump disposal. More competent rock is used in road construction and maintenance.	Tailings pond disposal.

.....Table cont'd
Footnotes on p. 28.

TABLE 3

Mineral Wastes - Metal Mining Operations (cont'd)

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
13. Newmont Mines Limited, Granduc Operating Div., Tide Lake, Stewart Area.	Underground mine - copper. Mill capacity - 7,000 tpy; crushing, grinding, flotation. Ore zone occurs in sediments and volcanics, limestone to argillites, some volcanics and diorites.	Amount**	Small.	Substantial.
		Size, pH, Sp Gr		80% minus 150 µm.
		Type or Constituents***		P.C. - silica, alumina, hematite. M.C. - magnesium oxide and traces of copper, silver, gold, lead, zinc.
		Current or Potential Use	Rock dump disposal. Remote location would limit use to local applications.	Stream disposal. Remote location would limit use to local applications.
14. Newmont Mines Limited, Similkameen Division, Princeton.	Open pit - copper. Mill capacity - 20,000 tpd; crushing, grinding, flotation. Pyrometasomatic alteration of andesitic volcanic flows and intrusives, adjacent to monzonite - syenite intrusive complex with erratic chalcopyrite mineralization.	Amount**	200 million tonnes (28 million tpy).	150 million tonnes (7 million tpy).
		Size, pH, Sp Gr	Pit run, minus 1 m.	90% minus 150 µm, 8.6; 2.84.
		Type of Constituents***	Volcanic rock - dense, homogeneous, grey-green, with fine-grained sulphide minerals (pyrrhotite and pyrite). Volcanic rock (altered) - green-grey with irregular masses of pink mineral, indistinct texture.	P.C. - plagioclase, pyroxene. M.C. - sulphur, calcite, chlorite, mica, quartz.
		Current or Potential Use	Rock dump disposal. Possible use by Dept. of Highways for local roads and highways.	Tailings pond disposal. Current studies of Granby tailings re recovery of metal content, use in building products, and as oil absorbent.

.....Table cont'd
Footnotes on p.28.

TABLE 3

Mineral Wastes - Metal Mining Operations (cont'd)

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
15. Noranda Mines Ltd., Bell Copper Division, Babine Lake.	Open pit - copper. Mill capacity - 12,500 tpd; crushing, grinding, flotation.	Amount**	15 million (2.5 million tpy).	16 million (5 million tpy).
		Size, pH, Sp Gr	Pit run, minus 1 m.	70% minus 150 µm; 8.4; 2.85
		Type or Constituents***	Argillite - dense, fine-grained, fractured, greenish-gray, moderately soft with fine-grained pyrite in fractures. Feldspar porphyry-altered, chalky white feldspar, greenish-gray interstitial mafic materials, disseminated pyrite.	P.C. - quartz, mica. M.C. - kaolin, pyrite, plagioclase, quartz. (SiO_2 - 66.4%, Al_2O_3 - 12.35%, Fe - 6.5%, S - 2.60%, MgO - 1.31%, CaO - 0.67%, Cu - 0.08%)
		Current or Potential Use	Rock dump disposal. Used in construction of tailings pond impoundment dams.	Tailings pond disposal. Possible recovery of molybdenium.
16. Noranda Mines Limited, Boss Mountain Division, Hendrix Lake.	Underground mine - molybdenum. Mill capacity - 1,600 tpd; crushing, grinding, flotation. Molybdenum mineralization is contained within quartz veins or breccia bodies in granodiorite.	Amount**	Minor.	5.6 million tonnes (550,000 tpy).
		Size, pH, Sp Gr	Minus 30 cm.	60% minus 150 µm; 9.1; 2.71.
		Type of Constituents***	Granodiorite - coarse-grained homogeneous, massive, with sulphides in disseminated grains and small veinlets. Breccia - variable, white to black in colour, dense, with veinlets of quartz and pyrite.	P.C. - mainly quartz. M.C. - magnesium, calcium, iron. (Fe - 2.50%, MgO - 0.70%, CaO - 0.60%, Cu - 0.08%, MoS_2 - 0.05%, Pb - 0.01%).
		Current or Potential Use	Rock dump disposal. Granodiorite mainly used for road construction and tailings dam.	Tailings pond disposal.

.....Table cont'd
Footnotes on p.28 .

TABLE 3

Mineral Wastes - Metal Mining Operations (cont'd)

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
17. Northair Mines Ltd., Brandywine	Underground mine - gold, silver, lead, zinc. Mill capacity - 270 tpd; crushing, grinding, flotation, jigs.	Amount**	Minor.	Minor.
		Size, pH, Sp Gr		
		Type or Constituents***		
		Current or Potential Use		
18. Teck Corporation Ltd., Beaverdell.	Underground mine - lead, zinc, silver. Mill capacity - 100 tpd; crushing, grinding, flotation. Ore minerals in vein formation in quartz diorite.	Amount**	Minor (11,000 tpy).	Small (30,000 tpy).
		Size, pH, Sp Gr		65% minus 150 µm; 8.8; 2.99.
		Type of Constituents***	Quartz diorite.	P.C. - quartz, mica, chlorite M.C. - plagioclase.
		Current or Potential Use	Rock dump disposal. Road maintenance and tailings pond impoundment dams.	Tailings pond disposal. Portion of old tailings may be of sufficient grade for remilling at some time in the future.

.....Table cont'd
Footnotes on p. 28.

TABLE 3

Mineral Wastes - Metal Mining Operations (cont'd)

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
19. Utah Mines Limited, Island Copper mine, Port Hardy.	Open pit - copper, molybdenum. Mill capacity - 34,500 tpd; crushing, grinding, flotation.	Amount**	Large (36 million tpy).	Substantial (12.5 million tpy).
		Size, pH, Sp Gr	Pit run, minus 1 m.	80% minus 150 µm; 8.9; 2.80.
		Type or Constituents***	Volcanic - fine-grained, grey-green aphanitic. Pyrophyllite breccia - similar to volcanics but extensively sheared and brecciated. Dumortierite - grey-violet, fine-grained, soft. Feldspar - coarse-grained with rounded grains of quartz.	P.C. - quartz, plagioclase, pyrite. M.C. - chlorite, mica.
		Current or Potential Use	Rock dump disposal.	Tailings pond disposal. Continued research to improve recovery of copper and molybdenum. Cement companies have found K_2O content of tailings too high for use in Portland cement manufacture.
20. Westfrob Mines Ltd., Tasu, Queen Charlotte Islands.	Underground mine - magnetite, copper. Mill capacity - 1.0 million tpy (concentrates): crushing, grinding, magnetic separation, flotation. Ore zone occurs in limestone skarn with magnetite, chalcopyrite, amphibole, chlorite, pyrite. Note: Formerly an open pit operation.	Amount**	Substantial (from former open pit), 10,000 tpy from underground, 3.0 million tons of magnetic rejects (165,000 tpy).	290,000 tpy of copper tails, 14,000 tpy of iron sulphide tails.
		Size, pH, Sp Gr	Magnetic rejects, minus 6.5 cm.	70% minus 45 µm; 8.6; 3.20.
		Type of Constituents***	Magnetic rejects - volcanic 90%, fine-grained, massive, green rock with little variation in grain size or structure, some disseminated sulphide. Limestone 5%, mineralized 5%, (SiO_2-20%, CaO-12%, Fe-8%, Mg-2%, S-0.55%, Cu-0.04%).	P.C. - calcite, magnetite, quartz. M.C. - plagioclase, pyrite, pyrrhotite. Copper tails - 8.2% Fe, 0.07% Cu. Iron tails - 55.0% Fe, 0.30% Cu.
		Current or Potential Use	Rock dump disposal. Magnetic rejects are of interest as aggregate material but location is distant from current markets.	Tailings are combined and discharged into salt water below the tidal zone.

.....Table cont'd
Footnotes on p. 28.

TABLE 3

Mineral Wastes - Metal Mining Operations (cont'd)

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
21. Western Mines Limited, Myra Falls, Vancouver Island.	Underground mine - copper, lead, zinc. Mill capacity - 700 tpd.; crushing, grinding, flotation. Ore zone occurs in volcanics with sulphides including chalcopyrite, sphalerite, galena, pyrite.	Amount**	Substantial (from former open pit).	Small - 180,000 tpd.
		Size, pH, Sp Gr		75% minus 150 µm.
		Type or Constituents***		P.C. - sericite, quartz, pyrite, chlorite. M.C. - feldspar, biotite.
		Current or Potential Use	Rock dump disposal.	Mine backfill.

* Locations shown in Fig. 4.

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

*** 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 - Industrial Mineral Mining Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
22. Baroid of Canada Ltd., Spillimacheen.	Recovery of barite from old lead-zinc tailings and from open pit mine. Mill capacity 90 tpd; tabling and jigging. Note: Operations expected to be terminated in 1978.	Amount**	Small.	Small.
		Size, pH, Sp Gr	95% minus 1 m (open pit).	Minus 2 cm (jig tails). Minus 2 mm (table tails).
		Type or Constituents***	Dolomite and argillite.	P.C. - shale and dolomite.
		Current or Potential Use	Rock dump disposal.	Jig tailings suitable as aggregate for road construction and maintenance.
23. Cassiar Asbestos Corporation Limited, Cassiar.	Open pit mine - asbestos. Mill capacity - 3,600 tpd; cruching, screening, aspiration, grading. Asbestos occurs with serpentine in ultra basic intrusive.	Amount**	Large (11.5 million tpy).	Large (1.1 million tpy).
		Size, pH, Sp Gr	Pit run, minus 1 m.	Rejects are generally minus 500 µm but can be up to 1 in.; 8.0;2.73.
		Type of Constituents***	Serpentinite - dense, black with green veinlets of platy serpentine minerals, irregular fractures. Argillite - dense, black, hard rock with splintery fracture.	P.C. - serpentine, magnetite. M.C. - quartz.
		Current or Potential Use	Rock dump disposal. Serpentine has limited potential as source of nickel or chromium.	Tailings disposal area. May be remilled to recover low-grade fibre and is a potential source of iron, nickel and chromium (see reference No. 8).

.....Table cont'd
Footnotes on p. 30.

TABLE 4

Mineral Wastes - Industrial Mineral Mining Operations (cont'd)

* Locations shown in Fig. 4.

** Amount accumulated:

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

*** 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 - Coal Mining Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
24. Byron Creek Collieries Limited, Corbin, Kootenay Mining District.	Open pit mine - coal. Preparation plant under construction (1978); capacity 360 tph. Lower Kootenay formation (Jurassic-Cretaceous); medium volatile bituminous coal is associated with sandstone and shales.	Amount**	8 million tonnes (2.7 million tpy).	Nil.
		Size, pH, Sp Gr	Pit run, minus 1 m.	Minus 5 cm.
		Type or Constituents***	Sandstone - angular, massive, impure with little or no bedding. Minor amount of shale, siltstone and claystone. Iron oxide staining on some fragments.	P.C. - shale, boney coal. M.C. - coal.
		Current or Potential Use	Rock dump disposal.	Tailings disposal area.
25. Fording Coal Limited, Elkford.	Open pit mine - coal. Plant capacity - 680 tph; heavy media separation and flotation. Medium to high volatile bituminous coal.	Amount**	1 million tpy.	2 million tons (180,000 tpy).
		Size, pH, Sp Gr	Minus 12, plus 1 cm.	Minus 850 µm; 8.1;2.34.
		Type of Constituents***	Sandstone, siltstone, mudstone. (80% ash)	P.C. - quartz, kaolin, mica, coal (60% ash). M.C. - siderite, magnetite, pyrite. Ash analysis: SiO_2 - 55%, Al_2O_3 - 35% Fe_2O_3 - 3%, CaO - 2.5%, TiO_2 - 1.4%, P_2O_5 - 1.3%, MgO - 0.8%, SO_3 - 0.4%, Na_2O - 0.3%, K_2O - 0.3%.
		Current or Potential Use	Used for road and dike building, back filling, etc. Of potential interest for lightweight aggregate manufacture.	Ash content of tailings 30 to 60%. Tailings are of potential interest for reprocessing to recover coal and as source material for coal gasification, followed by alumina recovery.

.....Table cont'd
Footnotes on p.33 .

TABLE 5

Mineral Wastes - Coal Mining Operations (cont'd)

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
26. Kaiser Resources Ltd., Harmer strip mine, Sparwood. (preparation plant at Elkview).	Open pit mine - coal. Plant capacity - 1,450 tph; heavy media separation, water cyclones, flotation.	Amount**	218 million m^3 (27 million m^3/year).	Coarse 6 million tonnes (1.3 million tpy). Fine 4 million tonnes (.5 million tpy).
		Size, pH, Sp Gr	Pit run - minus 1.5 m, 70% minus 0.5 m.	Coarse - minus 10 cm plus 850 µm. Fines - minus 850 µm; 6.0; 2.02.
		Type or Constituents***	Sandstone - angular fragments of massive, medium-grained, dark grey rock with no visible bedding, minor shale, claystone and siltstone.	P.C. - quartz, kaolin. M.C. - mica, magnetite. Coarse - coal, 40% ash, 4% H_2O, 19.5 MJ/kg Fine - coal, 37% ash, 16% H_2O, 22 MJ/kg
		Current or Potential Use	Rock dump disposal.	Tailings disposal area. Of potential interest as feed material for thermal power plant.
27. Kaiser Resources Ltd., Michel colliery, Michel.	Underground mine - coal. Plant capacity - 180 tph; screening; additional processing at Elkview plant (above).	Amount**		
		Size, pH, Sp Gr		Coarse 1.5 million tonnes from old Michel plant, similar to Harmer coarse (above).
		Type of Constituents***		
		Current or Potential Use		

.....Table cont'd
Footnotes on p. 33.

TABLE 5

Mineral Wastes - Coal Mining Operations (cont'd)

* Locations shown in Fig. 4.

** Amount accumulated:

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

*** 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

Mineralogy - Mill Tailing Samples

Sample No.*	Constituents		
	Greater than 20%	10 to 20%	Less than 10%
Metals			
1	quartz, plagioclase	mica	chlorite
2	quartz, plagioclase	mica, feldspar	amphibole, chlorite
4	quartz, pyrrhotite	pyrite	mica, chlorite, plagioclase
5	dolomite	pyrite	calcite, quartz
6	quartz	plagioclase, amphibole	calcite, chlorite, dolomite, K-feldspar
8	quartz, plagioclase	--	mica, chlorite
11	quartz	mica, siderite	--
12	quartz, plagioclase	--	mica, chlorite, calcite
14	plagioclase	pyroxene	anhydrite(?), sulphur, calcite, chlorite, mica, quartz
15	quartz	mica	kaolin, pyrite, plagioclase, calcite
16	quartz, plagioclase	K-feldspar	pyrite
18	quartz	mica, chlorite	plagioclase
19	quartz, plagioclase	pyrite	chlorite, mica
20	magnetite, calcite	quartz, chlorite	plagioclase
Indust. Minerals			
23	serpentine (chrysotile)	magnetite	quartz
Coal			
25a	quartz, kaolin	mica	coal, siderite
25b	coal, quartz, kaolin	magnetite	mica, siderite, pyrite
26	coal, quartz, kaolin	--	mica, magnetite

*Numbers correspond to those in Tables 2 to 8, and on map, Fig. 4.

TABLE 7

Semi-Quantitative Spectrochemical Analyses* - Mill Tailing Samples

Sample No.**	Element, %																		
	Si	Fe	Al	Ca	Mg	Na	Mn	Pb	Sn	Cr	Cu	Zr	Ni	Co	Ba	Sr	Ag	Ti	Zn	Mo
1	P.C.	P.C.	P.C.	n.d.	P.C.	P.C.	0.01	n.d.	n.d.	n.d.	0.07	n.d.	0.01	n.d.	0.04	0.09	n.d.	n.d.	0.09	n.d.
2	"	"	"	"	"	"	0.01	"	"	"	0.06	"	0.01	"	0.08	0.09	"	"	n.d.	0.01
4	"	"	"	"	"	"	0.02	"	"	"	0.02	0.01	0.01	"	n.d.	n.d.	"	"	n.d.	n.d.
5	0.12	"	0.02	"	"	0.08	0.01	"	"	"	0.08	n.d.	n.d.	"	"	"	"	"	0.13	"
6	P.C.	"	P.C.	"	"	P.C.	0.09	"	"	"	0.38	"	0.08	"	0.07	0.08	"	"	"	0.01
8	"	"	"	"	"	"	0.01	"	"	"	0.10	"	0.01	"	0.07	0.08	"	"	n.d.	n.d.
11	"	"	"	"	"	"	0.15	"	"	"	0.07	0.01	0.08	"	0.01	0.01	"	"	0.15	0.01
12	"	"	"	"	"	"	0.09	"	"	"	0.32	"	0.08	"	0.10	0.10	"	"	n.d.	0.01
14	"	"	"	"	"	"	0.01	"	"	"	0.11	n.d.	0.01	0.01	n.d.	0.08	"	"	"	n.d.
15	"	"	"	"	"	0.11	0.01	"	"	"	0.10	"	n.d.	n.d.	"	n.d.	"	"	"	"
16	"	"	"	"	"	P.C.	0.08	"	"	"	0.18	"	0.08	"	0.11	0.08	"	"	"	0.01
18	"	"	"	"	"	"	0.11	"	"	"	0.05	"	0.01	"	0.01	0.01	"	"	0.09	0.01
19	"	"	"	"	"	"	0.06	"	"	"	0.10	"	n.d.	n.d.	n.d.	0.01	"	"	n.d.	n.d.
20	"	"	"	"	"	"	0.09	"	"	"	0.08	"	0.01	0.08	"	0.01	"	"	"	"

* principal elements, additional information available on request.
** numbers correspond to those in Tables 2 to 8, and on map, Fig. 4.
P.C. principal constituent, 1% or greater.
n.d. not detected, i.e., below the lowest limit of detection by this technique.

TABLE 8

Chemical Analyses - Mill Tailings Samples

Sample No.*	Compound - %							
	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	S	-	LOI
Metals								
1	63.69	3.53	16.28	3.47	1.49	0.11	-	2.54
2	63.84	3.65	14.48	3.43	1.83	0.09	-	1.65
4	44.73	25.40	10.87	2.80	4.18	9.34	-	6.82
5	5.13	7.38	0.56	27.92	16.89	5.61	-	32.04
6	47.91	15.19	12.27	11.72	4.25	0.09	-	6.75
8	63.09	4.49	14.52	2.84	1.68	0.27	-	2.16
11	65.76	6.08	10.30	2.28	1.94	0.74	-	5.52
12	67.88	1.70	15.05	2.30	0.40	0.11	-	2.30
14	50.62	5.78	16.63	8.95	4.02	1.73	-	3.20
15	62.80	8.06	13.61	2.01	1.55	2.57	-	6.22
16	62.45	4.56	14.84	3.42	2.54	0.86	-	1.36
18	61.67	5.08	14.17	3.60	0.93	0.59	-	3.50
19	60.09	8.76	14.82	3.04	3.93	1.96	-	3.48
20	27.48	30.95	7.39	16.23	4.07	2.36	-	6.96
Industrial** Minerals						Cr_2O_3	NiO	Water
23	39.73	5.34	1.35	0.00	39.54	0.36	0.27	13.36
Coal (dry basis)	H_2O	Ash	Volat. Mat.	Fixed C	S	Cal per g	B.T.U. per lb	
25 a	0.00	78.40	12.14	9.46	0.27	1019	1834	
25 b	0.00	46.54	17.72	35.74	0.36	4219	7594	
26	0.00	42.32	17.26	40.42	0.66	4632	8336	
Coal (ash analysis)	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	K_2O	P_2O_5	TiO_2
25 a	70.56	5.50	17.78	1.95	2.24	2.42	0.48	0.82
25 b	60.08	7.81	22.22	1.37	1.45	2.03	0.40	1.09
26	70.30	5.53	17.81	1.98	1.52	2.39	0.43	0.86

*Numbers correspond to those in Tables 2 to 8, and on map, Fig. 4.

**Serpentinite analysis, Cassiar Asbestos Corp. Ltd., by J.A. Maxwell, Geological Survey of Canada.

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