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MINERAL WASTE RESOURCES OF CANADA REPORT NO.1 - MINING WASTES IN ONTARIO

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Non-metallic and Waste Minerals Section

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MINERAL WASTE RESOURCES OF CANADA
REPORT NO. 1 - MINING WASTES IN ONTARIO

by

R.K. Collings*

- - -

SYNOPSIS

Mining and mineral processing wastes in Canada represent large reserves of non-renewable mineral resources. These largely untapped reserves of partially processed mineral material are being added to at an increasing rate as mining activity is expanded and as new technology for processing low-grade ore deposits is developed and applied.

Several factors, including legislation restricting mining operations near urban centres, increasing processing and transportation costs, increasing cost of energy, and environmental concern, have stimulated interest in mineral wastes and the potential of such wastes as raw material for a variety of uses, including construction material and ceramic applications. Unfortunately, this interest has been tempered by the fact that little information is available on the location, nature, and potential use of these wastes.

This report, Mining Wastes in Ontario, provides basic background information on mining and mineral processing wastes in Ontario. It hopefully will stimulate interest in such wastes and encourage both producer and potential consumer to undertake the necessary studies and research needed to effect a greater utilization of this material.

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LABORATOIRES DES SCIENCES MINERALES
MRP/MSL 75-253(R)

RAPPORT NO. 1 DE L'ORIGINE DES RESIDUS MINERAUX - RESIDUS DE MINE EN ONTARIO

par

R.K. Collings*

SYNOPSIS

Les résidus de mine et du traitement des minéraux au Canada représentent de larges réserves de ressources minérales non-renouvelables. Ces réserves de matières minérales partiellement traitées et en grande partie inutilisées s' accroissent continuellement à mesure que l'activité minière augmente et que la technologie de traitement des gisements de minerai à faible teneur se développe.

Plusieurs facteurs, incluant une législation limitant les opérations minières près des centres urbains, une augmentation des coûts de traitement et de transport, un accroissement du coût de l'énergie ainsi qu'un souci pour l'environnement, ont stimulé un intérêt dans les résidus minéraux et leur potentiel comme matières premières pour une variété d'usages, tels que certaines applications dans le domaine de la céramique et des matériaux de construction. Malheureusement, cet intérêt a été tempéré par le fait que peu d'information se trouve disponible concernant les lieux, la nature et le potentiel d'utilisation de ces résidus.

Ce rapport, Résidus de mine en Ontario, fournit de l'information de base sur les résidus de mine et du traitement des minéraux en Ontario. Il est à espérer qu'il stimulera de l'intérêt dans de tels résidus et qu'il encouragera les producteurs et les consommateurs virtuels à entreprendre les études nécessaires et la recherche requise pour permettre une plus grande utilisation de ces résidus minéraux.

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TABLE OF CONTENTS

INTRODUCTION

Canada has large resources of most metal and mineral ores, 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 favourably located industrial mineral deposits, and legislation restricting mining near urban centres, are forcing operators to look for and develop more distant deposits. The net result has been increased costs at all stages, from initial exploration through to the shipment of processed ore or mineral concentrate to markets. These factors have stimulated interest in research into the technical and economic feasibility of recovering mineral and metal values from lower-grade but more accessible mineral deposits, including mining wastes. Mining wastes, which includes mineral processing wastes, is the subject of this report.

Mining and mineral processing wastes in the form of waste rock and mill tailings are being generated and accumulated at a rate in excess of 300 million tons per year in Canada. In Ontario, approximately 80 million tons of mining wastes are generated annually. Until recently, little was known about these wastes apart from the fact that they were a nuisance, being costly to treat and to maintain in dumps and tailing piles. Today, however, they are regarded in a somewhat different light. Environmentalists, on the one hand, are concerned with the pollution hazards of these wastes with respect to air and water, whereas mining companies and other resource-oriented groups are showing increasing interest in the possibility of recovering additional metal and mineral values, e.g. zirconium and nickel from the Alberta tar sand tailings; of using these wastes as raw material for manufacturing various products, e.g. bricks and blocks; and in various miscellaneous applications such as soil additives, e.g. use of carbonate tailings to neutralize acid soils, and as raw material for use in certain chemical processes.

This current interest in mineral wastes has resulted in an increased need for information on the nature of these wastes, their mineralogy, and chemical and physical characteristics. Because of this increased interest and need for information, 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 our mineral waste resources; to investigate the technical feasibility of using these wastes for certain products and/or recovering contained mineral values; and to encourage research by industry in their utilization. As part of this 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 distribution was limited, interest in these reports has been keen. A decision was made to update and publish them to ensure that this information would be available to all interested groups. The present report, Mining Wastes in Ontario, is the first of a series. It is our intention to publish similar reports on mining wastes for four remaining areas of Canada - Quebec; British Columbia; the Prairie Provinces; and the Atlantic Provinces - during the next two years. These reports will deal with wastes from operating mines only. Mineral wastes from certain abandoned mining areas and from the metallurgical and chemical industries are also of interest and will be documented in future reports.

MINERAL WASTES

The preliminary reports (1-5) noted above contained a tabulation om mineral wastes by types. This is reproduced, in modified form, in Table 1 as an aid in classifying and understanding the nature of mineral wastes. Mineral wastes are here divided into four general categories. Those in the first two groups are large-volume, low-value mixtures of minerals and, as such, are usually unattractive for further economic exploitation. Overburden material can be used for roads or as land-fill and waste rock may be useful as construction aggregate; however, in most instances, the problem of storage of such wastes is best solved by long-term planned stabilization and/or landscaping. This would provide areas which could have greatly increased value for recreational use or as building sites. Groups three and four include wastes which, from any one plant, have been partially processed and are often uniform in character and grain size. These wastes could be potential sources of useful raw materials for the manufacture of construction and ceramic products, for the recovery of chemicals and minerals, and for use as mineral fillers in various products. The mining wastes considered in this report belong to Groups 2 and 3.

Mining Wastes in Ontario

For ease of reference, information on mining wastes in Ontario is presented in tabular form in Tables 3 to 10, pages 14 to 42. These tables list the main operating mines in Ontario, provide brief descriptions of the type of operation, geology and ore mineralogy, and describe the type or types of mineral wastes produced. Tonnage estimates and identified current and potential uses are noted. In addition, chemical, spectrochemical, and mineralogical data are given for about twenty select tailing samples.

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.	

Certain mines, for example gypsum and salt, produce very little waste mineral material and have not been included. The many sand and gravel pits, and stone and crushed stone quarries in Ontario have also been excluded although waste fines and/or coarse material may occasionally be available at such operations. As an aid to the reader, wastes are separated into five 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)
5. Uranium (Table 7)

Data for Tables 3 to 7 was obtained from a variety of sources including mine and mill operators, laboratory studies of representative samples, the preliminary Source Report of Mineral Wastes in Ontario (1), returns from a questionnaire to industry by the Department of the Environment, and from the technical press. Data from these tabulations should be studied and evaluated with that from Table 8, Mineralogy - Select Samples; Table 9, Semi-Quantitative Spectrochemical Analyses - Select Samples;and Table 10, Chemical Analyses - Select Samples; to arrive at a fuller appreciation of the nature and potential of these wastes. Data in these latter three Tables (8 to 10) was developed by CANMET staff and is based on representative samples of mine rock and mill tailings submitted by the noted companies.

The thirty-nine mining operations considered in this report are identified by numbers 1 to 39 in Tables 2 to 10 inclusive, pages 12 to 42. They are similarly identified by corresponding numbers on the Ontario map, Figure 1, page 13.

Base Metal Mines

Base metal mining operations, (copper, lead, zinc, nickel), are primarily concentrated in northeastern and western Ontario. Included in this group are both underground and open-pit or surface mines.

Waste rock from underground base metal mines normally does not represent a large tonnage, except during development work. This rock is left underground as backfill although it may be brought to the surface and used for road construction and maintenance. Waste rock from open pit mines, by contrast, is often measured in millions of tons and is mostly stockpiled. Such waste may find limited local use in road construction and as construction aggregate; however, large-tonnage uses are few because of the more or less remote locations of most of the mine sites. There are, of course, exceptions. Waste rock from the Sudbury area, for example, conceivably could be of interest as railroad ballast and as construction aggregate for markets in southern Ontario.

Mill tailings from base metal mining operations represent millions of tons. Collectively they are finely ground and contain relatively large percentages of metallic sulphides, chiefly pyrite and pyrrhotite. The impurity content and remote location limit use of these tailings to local, low-grade applications, e.g. as mine backfill, in road maintenance, and, on occasion, as smelter flux. They may contain small but significant metal values that could perhaps be recovered at some future date should metal prices increase. The pyrite and pyrrhotite may also be recoverable for conversion to sulphuric acid (and iron) should sulphur supplies again become critical. In the meanwhile, some base metal tailing piles are being revegetated and used as public parks or wild life areas.

Current base metal mining operations with available data on waste rock and mill tailings are noted in Table 3, page 14.

Iron Mines

Iron mining operations, with the exception of Marmora, are all in northern Ontario and all except the mine at Wawa are open pits.

These mines produce large tonnages of waste rock and whereas the bulk is sent to rock dumps, minor tonnages have and are being used in road construction, as crushed stone and construction aggregate, and, on occasion, as railroad ballast. Waste rock from certain operations, e.g., those that are close to centres of population and to rail and/or water transportation, could be of interest as construction aggregate. Trap rock from Marmora, for example, has been used as aggregate for asphalt. Other rock types from Marmora, e.g., andesite, diorite, and limestone, are currently being studied by CANMET investigators as aggregate in concrete and asphalt. Waste rock from the Wawa mine, being close to water transportation, could, at some future date, be of interest as a source of construction aggregate for cities bordering on the Great Lakes.

Iron ore milling and processing operations generate large tonnages of mill tailings, and whereas most of this tonnage is sent to tailing pond disposal areas, minor but significant tonnages have and are being used as fine aggregate in concrete and asphalt, 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 an iron mine at Shawville, Quebec (6).

Current iron ore mining operations with available data on waste rock and mill tailings are listed in Table 4, page 22.

Precious Metal Mines

Precious metal mining operations, (gold, silver), are largely concentrated in northeastern Ontario.

Mining is invariably by underground methods and waste rock production is usually not significant. Waste rock is left underground where it is used as backfill although it may be brought to the surface for use as crushed aggregate and in mine road construction.

Mill tailing tonnages, by contrast, are usually large. Mill tailings may, on occasion, be used as mine backfill but are normally sluiced to disposal areas.. Some tailings may contain traces of gold and silver which could become attractive with metal 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. In the more densely populated areas of northeastern Ontario, e.g. Timmins - Kirkland Lake, such tailings could be of interest for building products manufacture, e.g. sand-lime brick and concrete block. Current requirements of brick for this area are brought in from distant centres such as Toronto, Ottawa, and Montreal, as is the Portland cement used by concrete block manufacturing plants. 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; however, studies are continuing.

Current precious metal mining operations with available data on waste rock and mill tailings are listed in Table 5, page 27.

Industrial Mineral Mines

Industrial mineral mining operations in Ontario are chiefly in the southwestern section of the province (except for asbestos) and most are open pit mines. In contrast to metal mines, most industrial mineral or non-metallic operations do not generate significant tonnages of waste rock or mill tailings; however, where produced, these wastes, especially tailings, are usually of consistent composition and readily responsive to beneficiation by known mineral processing techniques. Wastes from the nepheline syenite operations north of Peterborough, for example, can be reprocessed through the plants to yield a 40 to 50 per cent recovery of glass-grade nepheline syenite. Wastes from industrial mineral operations in southern Ontario are generally favourably located with respect to prospective markets and are therefore of particular interest and worthy of detailed study to determine possible new applications. Trap rock fines from the roofing granule plant at Havelock, for example, are potentially valuable as filler material in rubber and asphalt. Also of interest is the possibility of producing mineral wool from asbestos tailings from the two mines in northeastern Ontario (Timmins area). Mineral wool was produced experimentally in the laboratory by CANMET researchers using tailings from a Quebec asbestos mine (7).

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

Uranium Mines

The two operating uranium mines in Ontario are underground and are both located in the Elliot Lake area. Each produces only minor tonnages of waste rock which is used locally for road construction and landfill purposes or sent to disposal areas. Production of mill tailings is relatively large, being in the order of 1.5 million tons per year per plant. These tailings are finely ground and mostly consist of quartz with minor feldspar, chlorite, and pyrite. Although attractive from the standpoint of re-use because of their proximity to the Great Lakes water system, residual radioactive minerals currently discourage and limit re-use possibilities. A major glass company expressed interest in these tailings as a source of silica for glass production several years ago. Investigation at that time demonstrated the technical feasibility of such use; however, development was not carried further because of a possible radiation hazard. Thorium and rare earth minerals contained in these tailings may be economically recoverable at some future date.

Available data on wastes from Ontario's two uranium mines are noted in Table 7, page 37.

Additional Data

Additional data on the nature and composition of Ontario's mining wastes was obtained by submitting select samples to CANMET laboratories for mineralogical, semi-quantitative spectrochemical, and chemical analyses. The results are included herewith in Tables 8, page 39; 9, page 41; and 10, page 42.

CONCLUDING REMARKS

This report is perhaps unique in that it represents the first serious attempt to gather together available data on the physical, chemical, and mineralogical nature of mining wastes in Ontario and to indicate 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 and encourage both "producer" and potential "consumer" to work together toward the goal of optimum utilization of these wastes. In some instances the physical nature, e.g. particle size, of the material may have to be adjusted to meet a potential use requirement; in others, chemical specifications, e.g. iron content, for a particular use might be unnecessarily high. Thus the producer, on the one hand, may be obliged to undertake further processing of the waste, whereas the consumer may have to lower specifications to permit use of this waste. Co-operation is the key, for without co-operation the ultimate potential of many of these wastes will never be realized.

The identification and development of viable uses for mineral wastes is a complex problem. It is not expected that the successful application of mineral wastes to particular end uses will 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 presents a challenge that should not go unheeded by industry and government, especially in view of developing shortages in energy and, in certain areas, raw mineral materials. Solutions will be difficult but the rewards can be well worthwhile.

Although it will not be feasible to use all the mineral wastes that now exist in Canada nor those that will be produced in the future, the successful utilization of even a small percentage of such wastes will aid conservation of our native, non-renewable mineral resources and the reduction of air, land, and water pollution.

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

TABLE 2
Company Identification Key

Company Name, Mine/Mill Location	Identification Number
Base Metal Operations	
Consolidated Canadian Faraday Ltd., Werner Lake	1
Texasgulf Canada Ltd., Timmins area	2
Falconbridge Nickel Mines, Ltd., Sudbury area	3
The International Nickel Company of Canada, Ltd., Sudbury area	4
Lynx-Canada Exploration, Long Lake	5
Mattabi Mine Limited, Thunder Bay region	6
Noranda Mines Limited, Manitouwadge	7
Pamour Porcupine Mines Limited, Timmins area	8
Prace Mining Limited, Batchawana Bay	9
Selco Mining Corporation Limited, Uchi Lake	10
Sheridan Geophysics Limited, Atika-Populus Lake	11
Willroy Mines Limited, Manitouwadge	12
Iron Ore Operations	
The Algoma Steel Corporation Limited, Wawa	13
Caland Ore Company, Atikokan	14
Cliffs of Canada Limited, Kirkland Lake area	15
Cliffs of Canada Limited, Temagami	16
Pickands Mather & Co., Red Lake district	17
Marmoraton Mining Company, Marmora	18
National Steel Corporation of Canada Limited, Sellwood	19
Steep Rock Mines Iron Mines Limited, Steep Rock Lake	20
Precious Metal Operations	
Agnico-Eagle Mines Limited, Cobalt area	21
Campbell Red Lake Mines Limited, Balmertown	22
Dickenson Mines Limited, Balmertown	23
Dome Mines Limited, South Porcupine	24
Hollinger Mines Limited, Holtyre	25
Kerr Addison Mines Ltd., Virginiatown	26
Madsen Red Lake Gold Mines Ltd., Madsen	27
Pamour Porcupine Mines Ltd., Timmins area	28
Teck Corp. Ltd., Cobalt	29
Willroy Mines Ltd., Kirkland Lake	30
Industrial Mineral Operations	
Canadian Johns-Manville Company, Limited	31
Hedman Mines Limited, Matheson area	32
Indusmin Limited, Badgeley Island and Midland	33a,33b
Indusmin Limited, Nephton	34
Sobin Chemicals (Canada) Ltd., Blue Mountain	35
Canadian Talc Industries Limited, Madoc	36
Minnesota Minerals Limited, Havelock	37
Uranium Operations	
Denison Mines Limited, Elliot Lake	38
Rio Algom Limited, Elliot Lake	39

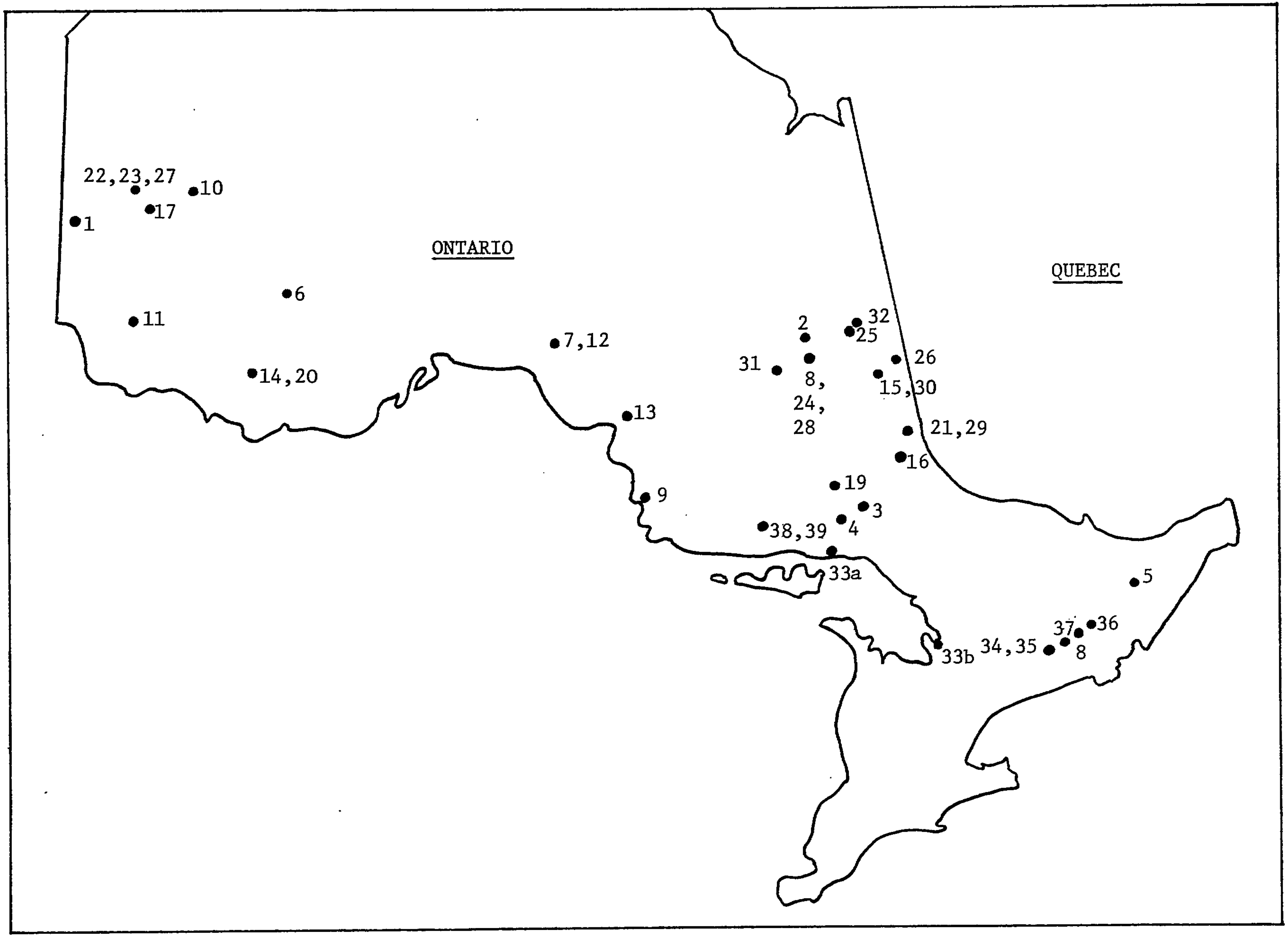

Figure 1. Location of Mining Operations Identified in Table 2

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. Consolidated Canadian Faraday Ltd., Werner Lake, 50 miles NW of Kenora.	Former nickel-copper producer, ceased operations mid-1972, custom milling of nickel-copper ore from Dumbarton Mines Ltd. continues; mill capacity - 1200 tpd; crushing, grinding, sizing, flotation. Ultrabasic rocks intruding sediments and volcanics.	Tonnage**	Small,800,000 tpy.	Substantial, 300,000 tpy.
		Size, pH, Sp Gr	minus 36, plus $\frac{1}{4}$ in.	85% minus 100 mesh, pH 9.5, Sp Gr 3.2.
		Type or Constituents***	andesite and serpentine.	P.C. pyrrhotite, serpentine, amphibole. M.C. chlorite, feldspar, biotite, quartz, carbonate.
		Current or Potential Use	Road and yard fill, remainder to rock dump (2 acres); local use only due to remote location.	Tailings pond disposal; remote location and high metallic sulphide content would limit use to local, low-grade applications, e.g., road maintenance or mine backfill; possible recovery of metal values.
2. Texasgulf Canada Ltd., Kidd Creek Mine and Hoyle Concentrator, Timmins area.	Open pit and underground mines, zinc-copper-lead-silver; mill capacity - 9000 tpd; crushing, grinding, sizing, flotation. Massive sulphides in rhyolite breccia and andesite; pyrite, chalcopyrite, sphalerite, minor graphite.	Tonnage**	50 million tons, (6 million tpy).	Large, 3 million tpy.
		Size, pH, Sp Gr		95% minus 100 mesh pH 10.7, Sp Gr 2.7.
		Type or Constituents***		P.C. pyrite (20%), chlorite (20%) quartz (50%). M.C. sericite, graphite, carbonate, muscovite, calcite, sulphides.
		Current or Potential Use	Minor tonnages used for road and yard fill, major tonnage to rock dump (1,000 acres); material from rock dump will be used to backfill underground mine.	Tailings pond disposal; remote location and high metallic sulphide content would limit use to local, low-grade applications e.g., road maintenance, mine backfill and as smelter flux. To commence stockpiling of pyrite concentrate in 1975, 500,000 tpy.

TABLE 3 (con't)

Mineral Wastes-Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
3. Falconbridge Nickel Mines, Ltd., Falconbridge and East Falconbridge Mines, Falconbridge Twp., Sudbury area.	Underground mines, nickel-copper; mill capacity - 3000 tpd, (Falconbridge Mill); crushing, grinding, sizing, flotation, magnetic separation. Massive and disseminated sulphides in norite; pyrrhotite, chalcopyrite, pentlandite, and other sulphides.	Tonnage**	None accumulated in waste piles.	Large, 200,000 tpy.
		Size, pH, Sp Gr		80% minus 100 mesh.
		Type or Constituents***		P.C. pyrrhotite (40%), feldspar (30%), quartz (10%), chlorite (10%). M.C. biotite
		Current or Potential Use	As backfill in mine and in mine yard maintenance.	Tailings pond disposal (100 acres).
3a. Falconbridge Nickel Mines, Ltd., Hardy, Boundary, Onaping, Fecunis, North Mines, Levack Twp., Sudbury area.	Underground mines and open pit (Hardy), nickel-copper; mill capacity - 2,400 tpd (Fecunis Lake Mill); crushing, grinding, sizing, flotation.	Tonnage**	Large, 60,000 tpy plus several million tons from Hardy Open Pit.	Large, 300,000 tpy (plus 300,000 tpy for backfill).
		Size, pH, Sp Gr		85% minus 100 mesh.
		Type or Constituents***		P.C. pyrrhotite (44%), feldspar (30%), quartz (20%). M.C. biotite, pyroxene.
		Current or Potential Use	As mine backfill, major tonnage to waste rock dumps (60 acres).	Mine backfill (50%), remainder to tailings pond disposal.

TABLE 3 (con't)

Mineral Wastes-Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
3b. Falconbridge Nickel Mines Ltd., Strathcona and Longvack Mines, Levack Twp., Lockerby Mine, Dennison Twp., Sudbury area.	Underground mines, nickel-copper; mill capacity - 9,300 tpd (Strathcona Mill); crushing, grinding, sizing, flotation. Massive and disseminated sulphides in norite; pyrrhotite, chalcopyrite, pentlandite and other sulphides.	Tonnage**	Large, 60,000 tpy.	Large, 1 million tpy plus 1 million tons for backfill.
		Size, pH, Sp Gr		75% minus 400 mesh.
		Type or Constituents***		P.C. pyrrhotite (40%), feldspar (30%), quartz (20%). M.C. tremolite, biotite, chlorite.
		Current or Potential Use	As mine backfill and landfill, major tonnage to waste rock dumps (60 acres).	Mine backfill (50%), remainder to tailings pond disposal.
4. The International Nickel Company of Canada, Ltd., Clarabelle Mill, Snider Twp., Sudbury area.	Underground and surface mines, copper-nickel; mill capacity - 35,000 tpd (Clarabelle Mill); crushing, grinding, sizing, magnetic separation, flotation. Norite; pyrite, chalcopyrite, pentlandite, and other sulphides.	Tonnage**	18 million tons, (Clarabelle Open Pit).	Substantial, 7 million tpy.
		Size, pH, Sp Gr	minus 5 ft.	70 minus 100 mesh
		Type or Constituents***	norite, greenstone, quartzite	P.C. feldspar (40%), amphibole (15%). M.C. quartz, pyroxene, biotite, magnetite, pyrrhotite.
		Current or Potential Use	Waste rock dump (105 acres), now being used as mine backfill for large open stopes in conjunction with cemented mill tailings.	Relatively small percentage of waste rock and a substantial amount of sand from mill tailings used as backfill in mines; some used as landfill for recreational parks, remainder to tailings pond disposal.

TABLE 3 (con't)

Mineral Wastes-Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
4a. The International Nickel Company of Canada, Ltd., Copper Cliff Concentrator, Snider Twp., Sudbury area.	Underground and surface mines, copper-nickel; flotation facilities at Copper Cliff Concentrator used to separate bulk copper-nickel concentrate from Clarabelle and Frood-Stobie Mills. Norite; pyrrhotite, chalcopyrite, pentlandite, and other sulphides.	Tonnage**	None from Copper Cliff Concentrator.	Large, 500,000 tpy.
		Size, pH, Sp Gr		80% minus 100 mesh.
		Type or Constituents***		P.C. feldspar (50%), amphibole (20%), quartz (10%). M.C. pyroxene, biotite, pyrrhotite, magnetite, pentlandite, chalcopyrite.
		Current or Potential Use		Tailings pond disposal, several areas totalling over 500 acres; abandoned areas being revegetated; one now a "wild-life" area .
5. Lynx-Canada Exploration, Long Lake Mine, Olden Twp., 40 miles N of Kingston.	Underground, zinc; mill capacity - 250 tpd; crushing, sizing, heavy-media separation.	Tonnage**	Minor, from heavy media plant.	
		Size, pH, Sp Gr		
		Type or Constituents***		
		Current or Potential Use	Road maintenance.	

TABLE 3 (con't)

Mineral Wastes-Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
6. Mattabi Mine Limited, Ignace Mine, 130 miles NW of Thunder Bay.	Open pit, zinc-lead-copper; mill capacity - 3,000 tpd; crushing, grinding, sizing, flotation. North-facing, north-dipping 65° to 75° sequence of volcanic rock (pyroclastic-ryolite-dacite, to andesite tuffs-agglomerates); stratabound, zoned accumulation-massive to semimassive sulphides, pyrite-sphalerite, chalcopyrite-galena, tetrahedrite-tennantite, arsenopyrite, pyrrhotite, in a volcano-clastic terrain.	Tonnage**	5.5 million tons.	Substantial, 400,000 tpy.
		Size, pH, Sp Gr	4 in. to 4 ft.	95% minus 100 mesh.
		Type or Constituents***	rhyolite, dacite, andesite, pyroclastics, pyrite.	P.C. pyrite (60%). M.C. pyrrhotite, quartz.
		Current or Potential Use	Rock dump disposal (30 acres), minor tonnage used in road maintenance; local use only due to remote location.	Tailings pond disposal; remote location and high metallic sulphide content would limit use to local, low-grade applications, e.g., landfill.
7. Noranda Mines Limited, Geco Mine, Manitouwadge.	Underground, copper-zinc-lead; mill capacity - 5,000 tpd; crushing grinding, sizing, flotation. Sulphide ore in quartz-muscovite schist.	Tonnage**	Minor.	Large, 1 million tpy.
		Size, pH, Sp Gr		80% minus 100 mesh.
		Type or Constituents***		P.C. quartz (30%), pyrite (25%). M.C. mica, pyrrhotite.
		Current or Potential Use	Mine backfill and road maintenance.	Mine backfill (30%), remainder to tailings pond disposal; location and high metallic sulphide content would limit use to local, low-grade applications, e.g., mine backfill and landfill.

TABLE 3 (con't)

Mineral Wastes-Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
8. Pamour Porcupine Mines, Limited, Schumacher, Timmins area.	Underground, gold-copper; mill capacity - 2,100 tpd; crushing, grinding, sizing, flotation (copper ore). Ore in altered quartz-feldspar porphyry; some molybdenite.	Tonnage**	Minor.	Substantial, 600,000 tpy.
		Size, pH, Sp Gr		85% minus 100 mesh.
		Type or Constituents***		
		Current or Potential Use		Tailings pond disposal, portion used as mine backfill.
9. Prace Mining Limited, Batchawana Bay, 40 miles N of Sault Ste-Marie.	Underground, copper; mill capacity - 500 tpd; crushing, grinding, sizing, flotation; closed since August 1974. Ore zone in silicious volcanic breccia.	Tonnage**	Minor.	Minor.
		Size, pH, Sp Gr		80% minus 200 mesh.
		Type or Constituents***		
		Current or Potential Use		Location of interest (close to water transportation).

TABLE 3 (con't)

Mineral Wastes-Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
10. Selco Mining Corporation Limited, South Bay Mine, Uchi Lake area, 50 miles E of Red Lake.	Underground, copper-zinc; mill capacity - 500 tpd; crushing, grinding, sizing, flotation, filtering, drying. Massive sulphides occur within acid volcanics (dacite breccia) and/or along the contact of quartz feldspar porphyry and dacite breccia; ore composed of pyrite, sphalerite and chalcopyrite, with lesser amounts of arsenopyrite, cassiterite, magnetite, and small amounts of galena, native silver, argentite, dyscrasite, bornite, etc.	Tonnage**	Minor, less than 10,000 tpy.	Small, less than 100,000 tpy.
		Size, pH, Sp Gr	Run of mine, up to 3 ft. size.	90% minus 200 mesh, pH 8.8.
		Type or Constituents***		P.C. pyrite.
		Current or Potential Use	Mostly used as mine backfill; may be crushed and used for road building, as fill, and as construction aggregate.	Tailings pond disposal, little re-use possibility because of pyrite content and remote location; possible to recover tin, lead and pyrite concentrate but uneconomic at present.
11. Sheridan Geophysics Limited, Maybrun Mine, Atika-Populus Lake, 50 miles SE of Kenora.	Open pit, copper-gold; mill capacity - 500 tpd; crushing grinding, sizing, flotation; mine and mill now closed.	Tonnage**		
		Size, pH, Sp Gr		
		Type or Constituents***		
		Current or Potential Use		Tailings pond disposal.

TABLE 3 (con't)

Mineral Wastes-Base Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
12. Willroy Mines Limited, Manitouwadge.	Underground, copper-zinc-lead; mill capacity - 1,700 tpd; crushing, grinding, sizing, flotation.	Tonnage**	Minor, 20,000 tpy.	Large, 400,000 tpy.
		Size, pH, Sp Gr		50% minus 100 mesh, pH 3.0.
		Type or Constituents***		P.C. quartz, feldspar, pyrite (15%), pyrrhotite (15%). M.C. mica.
		Current or Potential Use		Tailings pond disposal; remote location and high metallic sulphide content would limit use to local, low-grade applications, e.g., in road maintenance or as 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%.
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 the second column in this table - 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
13. The Algoma Steel Corporation, Limited, Algoma Ore Division, Wawa, 100 miles N of Sault Ste-Marie, 8 miles from Lake Superior.	Underground, iron; mill capacity - 8,000 tpd; crushing, sizing, heavy-media separation, pelletizing, sintering. Siderite and iron sulphides in banded sediments and volcanics; ore body is 200 ft. wide by 6,000 ft. in length.	Tonnage**	12 million tons (200,000 tpy).	Substantial, 100,000 tpy.
		Size, pH, Sp Gr	minus 1½ in. plus 28 mesh.	100% minus 65 mesh, 80% minus 200 mesh.
		Type or Constituents***	pyrite (8%), SiO_2 38%, Fe 20%.	P.C. pyrite (20%), quartz (15%) Fe 34%, SiO_2 14%, S 11% M.C. diorite; MgO 4.5%, Al_2O_3 2.3%, CaO 1.6%
		Current or Potential Use	Rock dump disposal (93 acres); local use in road construction. Location of interest (close to water transportation).	Tailings pond disposal. Location of interest (close to water transportation).
14. Caland Ore Company, Atikokan, Steep Rock Lake area, 100 miles W of Thunder Bay.	Open pit, iron ore; pellet plant capacity - 3,400 tpd; crushing, grinding, screening, pelletizing, indurating. Goethite and hematite with minor pyrite and graphite in banded chert and tuff.	Tonnage**	Large, 8 million tpy.	No mill.
		Size, pH, Sp Gr	up to 8 ft.	
		Type or Constituents***	granite, ash rock, chert and silicious rocks.	
		Current or Potential Use	Stronger rock types are used for road fill.	

TABLE 4 (con't)

Mineral Wastes-Iron Ore Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
15. Cliffs of Canada Limited, Adams Mine, Boston Twp., Kirkland Lake area.	Open pit, iron; mill capacity-4,000 tpd (pellets); crushing, grinding, sizing, magnetic separation, flotation. Banded chert and magnetite in volcanic (andesitic) host rocks; chert, silica, magnetite, hematite, garnet, tremolite, actinolite, amphibole, chlorite, pyrite.	Tonnage**	30 million tons (2.5 million tpy).	23 million tons (2.3 million tpy).
		Size, pH, Sp Gr	minus 18 in.	60% minus 100 mesh.
		Type or Constituents***	volcanics, syenite, diabase.	P.C. silica, hematite, pyrite. M.C. garnet, epidote.
		Current or Potential Use	Rock dump disposal; minor tonnage used as railroad ballast and as crushed stone for driveways, foundation backfill, etc.	Minor tonnage used for road surfacing; sand fraction has been used in asphalt paving mixes.
16. Cliffs of Canada Limited. Sherman Mine, Temagami, 60 miles N of North Bay.	Open pit, iron; mill capacity-3,000 tpd (pellets); crushing, grinding, sizing, magnetic separation, flotation, pelletizing. Interbanded magnetite and chert with included waste rock, mainly iron silicates, sulphides, and carbonates.	Tonnage**	Small.	Large, 3.0 million tpy.
		Size, pH, Sp Gr	minus 18 in.	85% minus 100 mesh.
		Type or Constituents***	iron silicates, feldspar, mica.	P.C. chert, jasper. M.C. amphibole, carbonates.
		Current or Potential Use	Bulk of waste rock used in road and dike construction; possible use as railroad ballast, road fill, and construction aggregate.	Tailings pond disposal; possible use of sand fraction as fine aggregate in concrete.

TABLE 4 (con't)

Mineral Wastes-Iron Ore Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
17. The Griffith Mine, Pickands Mather & Co. Managing Agent, 30 miles south of Red Lake.	Open pit, iron ore mine and pelletizing complex; pellet plant capacity - 1.5 million tpy; crushing, grinding, sizing, magnetic separation, flotation, pelletizing. Metasedimentary iron formation bounded by quartz diorite pluton, intruded by feldspar porphyry dikes, interbedded with graywacke and complexly folded. Magnetite-quartz interlayered with chert or jasper with minor hematite; locally magnetite-quartz-biotite schist with iron silicates.	Tonnage**	Large, 5 million tons in 1975.	Substantial, 2.3 million tons in 1975.
		Size, pH, Sp Gr	up to 6 ft.	20% plus 200 mesh.
		Type or Constituents***	Fine grained, amphibole rich, coarse grained arkosic grit; graywacke with various proportions of quartz, biotite, amphibole, garnet, andalusite, actinolite, pyrite and magnetite; minor magnetite-quartz-biotite schist.	P.C. quartz (55%), biotite (25%), amphibole (15%). M.C. feldspar, chlorite, calcite, sulphides (pyrite), magnetite, hematite, iron silicates.
		Current or Potential Use	Rock dump disposal, small tonnages used in road and dyke construction.	Tailings pond disposal, small tonnage used in dyke construction.
18. Marmoraton Mining Company, Marmora, 120 miles NE of Toronto.	Open pit, iron; pellet plant capacity - 1,500 tpd; crushing, grinding, magnetic separation, pelletizing, sintering. Iron formation (magnetite), overlain by limestone.	Tonnage**	70 million tons.	9 million tons, (½ million tpy).
		Size, pH, Sp Gr	minus 18, plus 1 in.	90% minus 65 mesh.
		Type or Constituents***	limestone, syenite, trap rock.	P.C. SiO_2 40%, CaO 20%. M.C. pyrite, pyrrhotite, Al_2O_3 9%, MgO 8%, Fe 5%, S 1%.
		Current or Potential Use	Rock dump disposal (275 acres); minor tonnage of trap rock used as aggregate in asphalt paving, possible use as aggregate in concrete and for road construction and repair.	Tailings pond disposal, possible use in production of bricks and blocks.

TABLE 4 (con't)

Mineral Wastes-Iron Ore Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
		Use	Rock	Mill Tailings
19. National Steel Corporation of Canada Limited, Sellwood, 16 miles NW of Capreol.	Open pit, iron; mill capacity - 2,000 tpd; crushing, grinding, sizing, magnetic separation, flotation, pelletizing. Keewatin formation; taconite banded iron formation of low grade magnetite, quartz, various amphiboles and other minerals in minor quantities.	Tonnage**	22 million tons, (250,000 tpy), plus magnetic rejects, 2.2 million tons (290,000 tpy).	14 million tons.
		Size, pH, Sp Gr	85% plus 4 in., 15% minus 4 in. plus ¼ in., magnetic rejects 80% plus 7/8 in.	70% minus 100 mesh.
		Type or Constituents***	intermediate to mafic volcanics and/or metasediments; quartz, silicates, amphiboles.	P.C. quartz, silicates, amphiboles. M.C. iron minerals.
		Current or Potential Use	Rock dump disposal, minor tonnages used in road construction and maintenance.	Tailings pond disposal, no significant use yet identified.
20. Steep Rock Iron Mines Limited, Steep Rock Lake, 100 miles W of Thunder Bay.	Open pit, iron; mill capacity - 5,000 tpd; crushing, grinding, sizing, pelletizing, some gravity concentration. Hematite-goethite with chert, and minor pyrite.	Tonnage**	8.5 million cubic yards.	2 million tons (200,000 tpy).
		Size, pH, Sp Gr	minus 24 in.	90% minus 100 mesh.
		Type or Constituents***	carbonate and ash rock.	P.C. quartz, iron oxide, Fe 41%, SiO_2 26%. M.C. kaolin, Al_2O_3 1.5%, S 0.6%, Mn 0.3%.
		Current or Potential Use	Waste dump disposal, (over 600 acres); minor tonnages used in road construction and maintenance; waste rock from Hogarth Mine now being dumped in South Open Pit.	Tailings pond disposal; coarser sizes used in pit road construction and maintenance.

TABLE 4 (con't)

Mineral Wastes-Iron Ore Operations

* Locations noted in Figure 1.

** Tonnage accumulated:

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%.

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 the second column in this table - 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
21. Agnico-Eagle Mines Limited, Coleman Township, Cobalt area.	Underground mine, silver; mill capacity - 400 tpd; crushing, grinding, sizing, jigging, tabling, flotation. Keewatin rock types, diabase, Cobalt Series sediments.	Tonnage**	Minor, 7,000 tpy.	1.5 million tons, (30,000 tpy).
		Size, pH, Sp Gr	60% plus 4 in., 35% minus 4 in. plus ¼ in., 5% minus ¼ in	80% minus 100 mesh, pH 9.2.
		Type or Constituents***	intermediate volcanics and/or metasediments.	
		Current or Potential Use	Primarily used as landfill and as railroad ballast, remainder to rock dump disposal (2 acres); possible future ore.	Tailings pond disposal.
22. Campbell Red Lake Mines Limited, Balmertown, 100 miles NE of Kenora.	Underground mine, gold; mill capacity - 825 tpd; crushing, grinding, sizing, amalgamation, flotation, cyanidation. Quartz veins in andesite and rhyolite tuff.	Tonnage**	Minor.	Large.
		Size, pH, Sp Gr		
		Type or Constituents***		
		Current or Potential Use		Tailings pond disposal; remote location would limit use to local, low-grade applications, e.g., backfill and road maintenance.

TABLE 5 (con't)

Mineral Wastes-Precious Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
23. Dickenson Mines Limited, Balmertown, 100 miles NE of Kenora.	Underground mine, gold; mill capacity - 450 tpd; crushing, grinding, sizing, amalgamation, flotation, cyanidation. Quartz-carbonate veins in andesite and rhyolite tuff.	Tonnage**	Small.	Large.
		Size, pH, Sp Gr	90% minus 6 in.	95% minus 325 mesh.
		Type or Constituents***	andesite, diorite, rhyolite.	
		Current or Potential Use	Road construction and building sites (fill); suitable for use as crushed aggregate.	Tailings pond disposal.
24. Dome Mines Ltd., South Porcupine.	Underground mine, gold; mill capacity - 2000 tpd; crushing, grinding, amalgamation, cyanidation, gravity separation. Quartz and ankerite veins and lenses in sediments and volcanics, minor sulphides.	Tonnage**	Minor.	30 million tons, (400,000 tpy).
		Size, pH, Sp Gr		98% minus 100 mesh.
		Type or Constituents***	chlorite, quartz, sulphides, schist.	P.C. quartz, feldspar. M.C. pyrite, pyrrhotite.
		Current or Potential Use	Used as backfill or sold for construction purposes, e.g., road maintenance and repair.	Mine backfill (25 to 30%), remainder to tailings pond disposal; possible use in brick and block manufacture.

TABLE 5 (con't)

Mineral Wastes-Precious Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
25. Hollinger Mines Ltd. Holtyre.	Underground mine, gold; mill capacity - 400 tpd; crushing, grinding, sizing, flotation, cyanidation.	Tonnage**	Nil.	4.3 million tons, (135,000 tpy).
		Size, pH, Sp Gr		65% minus 200 mesh.
	Gold occurs in quartz stringers in lenses, pipes and tabular zones; silver and minor base metal sulphides. Host rocks are eruptive breccias and tuffs intruded by small stocks of red syenite. Ore bodies are related spatially to fault systems. Hydrothermal alteration is widespread.	Type or Constituents***		P.C. quartz (20%), carbonate (calcite & dolomite), chlorite, feldspar and other silicates. M.C. gypsum, mica, pyrite, chalcopyrite, sphalerite, galena, tennantite.
		Current or Potential Use	Used as fill at mine site.	Tailings pond disposal; copper in tailings is 0.1% but investigations show it cannot be economically reclaimed
26. Kerr Addison Mines Ltd. Virginiatown, Kirkland Lake area.	Underground mine, gold; mill capacity - 1,500 tpd; crushing, grinding, sizing, cyanidation, flotation, roasting, leaching.	Tonnage**	Minor.	Large, 150,000 tpy.
		Size, pH, Sp Gr	minus 6 in.	95% minus 325 mesh, 2.9, pH 8.8.
	Quartz veins in carbonatized volcanics and talc-chlorite schist.	Type or Constituents***	andesites, tuffs, talc-chlorite schists.	P.C. quartz, carbonate, feldspar. M.C. pyrite.
		Current or Potential Use	Used as roadbed material and as backfill in stopes which open to surface.	Sand fraction, plus 150 mesh, used for backfill (about 50%), remainder to tailings pond disposal; preliminary research by CANMET showed minus 150 mesh to be unsatisfactory for sand-lime and dry-pressed brick manufacture, and as pozzolanic additive to concrete.

TABLE 5 (con't)

Mineral Wastes-Precious Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
27. Madsen Red Lake Gold Mines Ltd., Madsen, 100 miles N of Kenora.	Underground mine, gold; mill capacity - 830 tpd; crushing, grinding, sizing, amalgamation, cyanidation. Gold in intermediate tuff with feldspar porphyry.	Tonnage**	Minor.	Substantial, 80,000 tpy.
		Size, pH, Sp Gr		98% minus 100 mesh.
		Type or Constituents***		
		Current or Potential Use	Road and yard maintenance.	Mine backfill (45%), remainder to tailings pond disposal; remote location limits use to local, low-grade applications, e.g., road maintenance.
28. Pamour Porcupine Mines Ltd., Pamour, Hallnor, Aunor Mines, Pamour.	Underground mines, gold; mill capacity - 2,500 tpd; crushing, grinding, sizing, flotation, cyanidation. Gold associated with quartz and calcite; host rocks include andesite, greywacke, conglomerate.	Tonnage**	Minor.	Large, flotation and cyanide tailings,
		Size, pH, Sp Gr		flotation tails, 80% minus 100 mesh; cyanide tails, 95% minus 325 mesh.
		Type or Constituents***		P.C. flotation tails - quartz, silicates, carbonates. cyanide tails - metallic sulphides (40%).
		Current or Potential Use	Mine backfill.	Tailings pond disposal; flotation tailings may be of interest in sand-lime brick manufacture.

TABLE 5 (con't)

Mineral Wastes-Precious Metal Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
29. Teck Corp Ltd., Silverfields Div., Cobalt.	Underground mine, silver; mill capacity - 270 tpd; crushing, grinding, sizing, gravity separation, flotation. Calcite veins in volcanics, cobalt sediments and syenite.	Tonnage**	Minor, 1000 tpy.	Minor, 74,000 tpy.
		Size, pH, Sp Gr		75% minus 100 mesh.
		Type or Constituents***		P.C. quartz (75%), carbonate.
		Current or Potential Use	Rock dump disposal (3 acres).	Tailings pond disposal; possible use in manufacture of brick and block.
30. Willroy Mines Ltd., Kirkland Lake.	Underground mine, gold; mill capacity - 500 tpd; crushing, grinding, sizing, cyanidation. Quartz veins in sediments and syenite.	Tonnage**	Nil.	4 million tons (100,000 tpy).
		Size, pH, Sp Gr		95% minus 325 mesh
		Type or Constituents***		P.C. quartz, feldspar, pyrite, augite; SiO_2 60%, Al_2O_3 15%, $Na_2O + K_2O$ 10%. M.C. biotite.
		Current or Potential Use	Mine backfill.	Tailings pond dispoaal (40 acres).

TABLE 5 (con't)

Mineral Wastes-Precious Metal 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%.
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 the second column in this table - 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
31. Canadian Johns-Manville Company, Limited, Timmins area.	Open pit, asbestos; mill capacity 5000 tpd (ore), 120 tpd (fibre); crushing, grinding, sizing, aspiration; closed May 1, 1975.	Tonnage**	Substantial.	Substantial.
		Size, pH, Sp Gr	minus 4 ft.	minus 3 in.
		Type or Constituents***	serpentine.	P.C. serpentine (95%) M.C. short asbestos fibre and diabase dike material.
		Current or Potential Use	Road base.	Road fill.
32. Hedman Mines Limited, Matheson area.	Open pit, asbestos; mill capacity - 300 tpd. (fibre); crushing, grinding, sizing, aspiration.	Tonnage**		
		Size, pH, Sp Gr		
		Type or Constituents***		
		Current or Potential Use		

TABLE 6 (con't)

Mineral Wastes-Industrial Minerals Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
33. Indusmin Ltd. (a) Badgeley Island (mine) (b) Midland (mill).	Open pit, silica; mill capacity - 3,000 tpd (crushing); crushing, grinding, sizing, magnetic separation. Massive quartzite, low iron, low alumina.	Tonnage**	Minor.	Infrequent "surplus" of silica fines (flour), up to 300 tons per week, plus magnetic iron rejects.
		Size, pH, Sp Gr		85% minus 200 mesh, 65% minus 325 mesh.
		Type or Constituents***		P.C. quartz (SiO_2 99%), M.C. mill iron (magnetic rejects).
		Current or Potential Use		Silica fines marketed as filler material, iron rejects sold to steel plants; possible use of silica fines in lime-silicate brick manufacture.
34. Indusmin Ltd., Nephton, 35 miles NE of Peterborough.	Open pit, nepheline syenite; mill capacity - 1,300 tpd; crushing, grinding, sizing, magnetic separation. Ore body associated with granite and crystalline limestone.	Tonnage**	Minor.	Substantial.
		Size, pH, Sp Gr		60% minus 100 mesh, 20% minus 150 mesh.
		Type or Constituents***		P.C. nepheline, feldspar, mica, SiO_2 56%, Al_2O_3 23%. M.C. hornblende, magnetite, Fe_2O_3 5%.
		Current or Potential Use		Tailings dump disposal; as future ore, may be reprocessed to recover up to 50% of nepheline and feldspar for use in glass manufacture.

TABLE 6 (con't)

Mineral Wastes-Industrial Minerals Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
35. Sobin Chemicals (Canada) Ltd., Blue Mountain, 35 miles NE of Peterborough.	Open pit, nepheline syenite; mill capacity - 800 tpd; crushing, grinding, sizing, magnetic separation. Ore body associated with granite and crystalline limestone.	Tonnage**	Minor.	Substantial.
		Size, pH, Sp Gr		25% minus 150 mesh.
		Type or Constituents***		P.C. nepheline syenite, feldspar, mica, SiO_2 55%, Al_2O_3 23%. M.C. hornblende, magnetite. Fe_2O_3 7%.
		Current or Potential Use		Tailings dump disposal; as future ore, may be reprocessed to recover up to 50% of nepheline and feldspar for use in glass manufacture.
36. Canadian Talc Industries Limited, Madoc.	Underground mine, talc-dolomite; mill capacity - 120 tpd; crushing, grinding, sizing,	Tonnage**	Minor, about 3000 tpy.	Negligible.
		Size, pH, Sp Gr	minus 10 in.	
		Type or Constituents***	off- colour talc and dolomite.	
		Current or Potential Use		

TABLE 6 (con't)

Mineral Wastes-Industrial Minerals Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
37. Minnesota Minerals Limited. Havelock.	Open pit, trap rock for roofing granules; mill capacity - 1600 tpd; crushing, sizing, colouring of granules.	Tonnage**	Negligible.	Substantial.
		Size, pH, Sp Gr		100% minus 20 mesh, 35% minus 150 mesh, S.G. 2.9.
		Type or Constituents***		P.C. trap rock; SiO_2 45%, Al_2O_3 22%.
		Current or Potential Use		Tailings dump disposal; possible use as filler in rubber and asphalt mixes.

* 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%.

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 the second column in this table - Type of Operation, Geology and Ore Mineralogy.

TABLE 7

Mineral Wastes - Uranium Operations

Company Name, Mine/Mill Location*	Type of Operation, Geology and Ore Mineralogy	Mineral Wastes		
			Rock	Mill Tailings
38. Denison Mines Limited, Elliot Lake.	Underground mine, uranium; mill capacity - 6,000 tpd; crushing, grinding, sizing, acid leaching. Silicious sediments (quartzite and conglomerate) with pyrite and thorium.	Tonnage**	Minor, 20,000 tpy.	Large, 1.5 million tpy.
		Size, pH, Sp Gr		80% minus 100 mesh.
		Type or Constituents***		P.C. quartz; SiO_2 85%. M.C. pyrite, feldspar.
		Current or Potential Use	Rock dump disposal, road construction and landfill.	Tailings pond disposal; no significant use yet identified; residual radioactive minerals could discourage re-use.
39. Rio Algom Limited, Elliot Lake.	Underground mine, uranium; mill capacity - 4,700 tpd; crushing, grinding, acid leaching, solid-liquid separation, ion exchange, precipitation. Silicious sediments (quartz and agglomerate) with pyrite and thorium.	Tonnage**	Minor, 125,000 tpy.	Large, 1.5 million tpy.
		Size, pH, Sp Gr		65% minus 100 mesh.
		Type or Constituents***	diabase, quartzite, argillite.	P.C. quartz, M.C. chlorite, pyrite.
		Current or Potential Use	Rock dump disposal, road construction and landfill.	Tailings pond disposal; no significant use yet identified; residual radioactive minerals could discourage re-use; future potential for recovery of thorium and rare earth complexes.

*	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%.
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 the second column in this table - Type of Operation, Geology and Ore Mineralogy.

TABLE 8

Mineralogy - Select Samples

Sample* Identification	Constituents		
	Greater than 20%	10 to 20%	Less than 10%
Base Metals			
1	magnetite, talc, serpentine	calcite, dolomite, chlorite	ilmenite, pyrite, hematite, quartz
7	quartz, pyrite	plagioclase	mica, K-feldspar, amphibole
8	pyrite, quartz, gypsum	dolomite	chlorite, mica, plagioclase
10	quartz, pyrite	-	plagioclase, mica chlorite, siderite
12	quartz, pyrite	plagioclase	amphibole, chlorite
Iron			
15	quartz, pyrite, magnetite	amphibole	plagioclase
16	quartz	magnetite, talc	pyrite, hematite, plagioclase, chlorite
17	quartz, magnetite	plagioclase, K-feldspar	amphibole, mica
19	quartz	amphibole	chlorite, mica, calcite
20	quartz, hematite, goethite	-	mica

*numbers correspond to those noted in Tables 2 to 7, 9 and 10, and to locations

TABLE 8 (con't)

Mineralogy - Select Samples

Sample* Identification	Constituents		
	Greater than 20%	10 to 20%	Less than 10%
Precious Metals			
21	quartz, plagioclase, amphibole	-	chlorite, mica
24	quartz, dolomite, plagioclase	chlorite	mica, pyrite
25	quartz, dolomite, plagioclase	mica, pyrite, calcite	chlorite, K-feldspar
26	quartz, dolomite, plagioclase	-	chlorite, mica gypsum, pyrite, K-feldspar
28	quartz, plagioclase, dolomite, chlorite	mica	K-feldspar
29	quartz, plagioclase	chlorite	calcite
30	quartz, dolomite, plagioclase	K-feldspar, pyrite	amphibole, chlorite mica
Industrial Minerals			
33	quartz	-	-
34	plagioclase, K-feldspar	mica	magnetite, quartz, calcite, chlorite
35	plagioclase, K-feldspar, mica	calcite, pyroxene	-
37	plagioclase, amphibole, quartz, chlorite	-	K-feldspar, dolomite
Uranium			
39	quartz	-	mica, pyrite

*numbers correspond to those noted in Tables 2 to 7, 9 and 10, and to locations on map, Figure 1.

TABLE 9

Semi-Quantitative Spectrochemical Analysis* - Select Samples

Sample** Ident.	Element-Percent																		
	Si	Fe	Al	Ca	Mg	Na	Mn	Pb	Sn	Cr	Cu	Zr	Ni	Co	Ba	Ga	V	Sr	Ag
Base Met.																			
1	P.C.	P.C.	0.28	P.C.	P.C.	n.d.	0.08	n.d.	0.05	0.35	0.05	n.d.	0.13	0.02	n.d.	n.d.	n.d.	n.d.	n.d.
7	"	"	0.31	0.75	"	0.50	0.04	0.19	0.05	n.d.	0.05	0.01	0.01	n.d.	"	"	"	"	"
10	"	"	0.36	0.78	"	0.61	0.11	0.42	0.09	"	0.10	0.02	0.04	0.04	"	0.04	"	"	0.01
12	"	"	P.C.	0.87	"	P.C.	0.05	n.d.	n.d.	0.04	0.05	0.01	0.02	n.d.	0.10	n.d.	0.01	0.06	n.d.
Iron																			
15	"	"	0.24	0.78	P.C.	n.d.	0.07	"	"	0.03	0.06	n.d.	0.04	0.01	n.d.	"	n.d.	n.d.	"
16	"	"	0.25	0.48	"	"	0.08	"	"	n.d.	0.06	n.d.	0.05	n.d.	"	"	"	"	"
17	"	"	0.33	P.C.	"	0.63	0.04	"	"	"	0.03	0.01	0.02	n.d.	0.17	"	"	"	"
19	"	"	0.33	"	"	0.40	0.05	"	"	0.06	0.05	0.01	0.04	0.06	n.d.	"	"	"	"
20	"	"	0.26	0.44	"	n.d.	0.09	"	"	0.05	0.01	n.d.	0.03	n.d.	"	"	0.01	"	"
Pre. Met.																			
21	"	"	P.C.	P.C.	P.C.	P.C.	0.10	0.30	"	0.06	0.08	0.01	0.04	0.03	"	"	0.02	n.d.	0.01
24	"	"	0.36	"	"	0.57	0.09	n.d.	"	0.05	0.03	0.01	0.04	n.d.	"	"	0.01	"	n.d.
25	"	"	P.C.	P.C.	P.C.	0.70	0.09	0.20	"	0.04	0.06	0.01	0.02	"	0.13	"	0.01	"	"
26	"	"	0.42	0.93	"	0.74	0.09	n.d.	"	0.07	0.04	0.02	0.04	"	n.d.	"	0.02	"	"
28	"	"	0.46	0.88	"	0.82	0.09	"	"	0.06	0.02	0.02	0.05	"	"	"	0.02	"	"
29	"	"	P.C.	P.C.	"	P.C.	0.05	"	"	0.05	0.05	0.01	0.04	0.04	"	"	0.01	"	"
Ind. Min.																			
33	"	0.27	0.16	n.d.	0.07	n.d.	n.d.	"	"	n.d.	0.01	0.01	0.02	n.d.	"	"	n.d.	"	"
34	"	P.C.	P.C.	0.48	P.C.	P.C.	0.05	"	"	"	0.01	n.d.	0.02	"	"	0.02	"	"	"
35	"	"	"	0.25	0.04	"	0.09	"	"	"	0.02	"	0.04	"	"	0.01	"	"	"
37	"	"	"	0.89	P.C.	"	0.08	"	"	"	0.05	0.01	0.02	0.01	"	n.d.	0.02	"	"
Uranium																			
39	"	"	0.38	P.C.	"	n.d.	0.01	0.23	"	"	0.01	0.01	0.03	n.d.	"	"	n.d.	"	"

* principal elements, additional information available on request.

** numbers correspond to those noted in Tables 2 to 8 and 10, and to locations on map, Figure 1.

P.C. principal constituent, one per cent or greater.

n.d. not detected, i.e. below the lowest limit of detection by this technique.

Pre. Met. precious metals.

Ind. Min. industrial minerals.

TABLE 10

Chemical Analyses - Select Samples

Sample* Identification	Compound - Per cent						
	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	S	LOI
Base Metals							
1	32.09	17.92	2.70	10.27	22.78	1.44	10.79
7	58.40	17.90	9.71	2.18	1.82	10.62	6.96
8	22.96	32.53	11.33	8.84	4.97	17.62	16.95
10	43.70	28.60	7.31	1.27	0.95	17.43	14.10
12	57.09	14.64	8.09	2.59	2.62	0.61	12.16
Iron							
15	65.86	21.76	1.59	2.88	1.96	8.51	5.33
16	76.13	15.21	2.51	1.08	2.42	0.45	1.97
17	72.45	14.23	7.44	2.78	2.90	0.08	0.02
19	69.44	17.50	2.32	3.01	4.01	0.31	0.26
20	35.55	48.21	1.95	3.68	1.38	0.11	7.88
Precious Metals							
21	54.01	9.02	16.36	6.36	4.99	0.14	3.05
24	56.18	9.66	13.23	4.56	4.28	0.94	7.37
25	59.67	4.79	13.70	4.25	3.50	1.26	5.59
26	39.90	10.66	11.34	8.45	6.15	2.10	14.70
28	54.31	7.68	14.36	7.44	4.61	0.54	7.39
29	65.94	5.48	15.11	2.57	2.88	0.07	2.78
30	52.48	6.92	12.53	5.86	4.11	1.56	6.65
Industrial Minerals							
33	99.33	0.19	0.38	0.03	0.02	0.01	0.42
34	56.25	4.98	23.44	1.20	0.40	0.03	1.56
35	59.54	1.32	24.19	0.45	0.09	0.03	1.16
37	48.02	15.22	12.97	9.75	4.91	0.02	3.28
Uranium							
39	77.78	4.00	6.49	2.84	0.16	4.01	4.76

*Numbers correspond to those noted in Tables 2 to 9, and to locations on map, Figure 1.

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